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### *Letters to the Editor*

# INTERNATIONAL CONFERENCE ON HIGH ENERGY ACCELERATORS AND INSTRUMENTATION

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THE Second International Conference on High Energy Accelerators and Instrumentation was held at CERN, Geneva, from September 14 to 19, 1959, under the auspices of the International Union of Pure and Applied Physics. The Conference was divided into two parts, one dealing with *Accelerating Machines* and the other with *Experimental Apparatus Used for Research with High Energy Accelerators.*

Sessions on the following subjects were held :—(1) Need for New Particle Accelerators ; (2) Advances in High Energy Particle Accelerators ; (3) Fundamental Limitations in Accelerators ; (4) Status Reports on High Energy Accelerators ; (5) Production, Transport and Separation of Particles from High Energy Machines ; (6) Bubble Chambers ; (7) Picture Evaluation for Track Chambers ; (8) Counters and other High Energy Particle Detectors.

The discussion on "The Need for New High Energy Accelerators" was led by Panofsky. As expected, one could find more concrete justification for higher intensity machines than for higher energy machines. There are large numbers of rare processes which one could study better if one had higher intensities. On the other hand, for higher energies, except for a few specific problems, there are no definite leads. It is argued that the present machine energies are above the threshold for production of all or nearly all the new particles which have been observed in working with cosmic rays where the available energies are much higher than what we may hope to achieve in the laboratory in any foreseeable future. However, because of the steepness of the cosmic ray spectrum and the difficulty of identifying particles at higher energies, it may be dangerous to conclude that the total species of particles produced by cosmic rays of the highest energies have actually been discovered. So one feels that, even from the point of view of discovery of new particles, the cosmic ray evidence cannot be used conclusively against the need for higher energy machines. As far as the problems of high energy nuclear interactions (such as the composition, angular distribution and energy distribution of the secondary particles, "inelasticity" and other features of the collisions) are concerned, one is only too familiar with the lack of numbers which the cosmic ray nuclear physicist is always plagued with. Therefore, in terms of ultimate productivity, working on particle physics with cosmic rays may be much more expensive than building higher energy machines. It may be mentioned that there is no general agreement on this point though at an accelerator conference one hardly expected to find many people who were against accelerators.

The following are some of the known problems in particle physics which could be solved with higher intensity machines (this is taken from Panofsky's report) :—(*i*) Branching ratios for various decay modes of particles. (*ii*) Structure of unstable particles from the study of their decays : $\mu \to e$ $\pi \to e$ $K \to e$ ; which involve high momentum transfers. (*iii*) Static properties of anti-nucleons and unstable particles. (This includes magnetic moments, electric dipole moments, etc.) (*iv*) Study of rare production processes in detail : unstable particle structure from the second order production processes. (*v*) Anti-hyperons and their properties. (*vi*) $K^0$-$\bar{K}^0$ interference phenomena in detail. (*vii*) Interactions of K-particles. (*viii*) Polarisation experiments.

Problems awaiting higher energy machines might be listed as : (*i*) Multiple meson production and its characteristics. (*ii*) Nucleon structure from electron scattering experiments at higher energies than available so far. (*iii*) The $\mu$-meson is a very curious particle and needs to be studied in great detail both by itself and as a probe. It is easier to get a pure $\mu$-meson beam for higher initial energies than at lower energies because of the possibility of filtering through large thicknesses of matter. (*iv*) New particles.

Higher energy electron machines are justified on the grounds that photo-production data are more amenable to interpretation. Further, one still needs to put better limits on the validity of Quantum Electrodynamics, for which higher energy in electron beams is required and higher intensities desirable.

In Table I is given a list of all the existing and planned multi-BeV Particle Accelerating Machines. As seen in that table, there were four proton machines and three electron machines operating at the time of this

TABLE I

*Multi-BeV Particle Accelerators*

| Accelerator | Completion date | Energy (BeV) | Focussing type | Cost (Rupees in crores) |
|---|---|---|---|---|
| PROTON MACHINES | | | | |
| Cosmotron, Brookhaven, U.S.A. .. | 1952 | 3·0 | weak | .. |
| Bevatron, Berkeley, U.S.A. .. | 1954 | 6·2 | weak | .. |
| Saturne, Saclay, France .. | 1958 | 2·5 | weak | 6 |
| Synchrophasotron, Moscow, U.S.S.R. .. | 1957 | 10 | weak | .. |
| Proton Synchrotron, Canberra, Australia | 1962–63 | 10 | weak | 1·1 estimate |
| Alternating Gradient Synchrotron, Brookhaven, U.S.A. | 1960 | 30 | strong | 14 |
| Proton Synchrotron, CERN, Geneva, Switzerland | 1959–60 | 25 | strong | 11 |
| Princeton-Pennsylvania Accelerator, Princeton, U.S.A. | 1960 | 3·0 | weak | .. |
| NIMROD, Harwell, U.K. .. | 1961–62 | 7·0 | weak | 9·5 |
| 7 BeV Synchrophasotron (Model for 50 BeV), Moscow, U.S.S.R. | 1959 | 7·0 | strong | .. |
| 50 BeV Synchrophasotron, Leningrad, U.S.S.R. | 1961 | 50·0 | strong | .. |
| Zero Gradient Synchrotron Argonne National Laboratory, U.S.A. | 1962 | 12·5 | weak (wedge) magnets | 14 |
| Southern Regional Accelerator, Oak Ridge, U.S.A. | design studies | 12 | .. | .. |
| ELECTRON MACHINES | | | | |
| Cal-Tech Synchrotron, U.S.A. .. | 1952 (500 MeV) 1956 (1 BeV) | 1·0 | weak | 62 lacs |
| Cornell Synchrotron, U.S.A. .. | 1955 | 1·5 (full energy not achived) | strong | 24 ,, |
| Frascatli Synchrotron, Italy .. | 1959 | 1·2 | weak | 70 ,, |
| Electron Synchrotron, Tokyo, Japan .. | end 1960 | 0·75–1·3 | strong | .. |
| Cambridge Electron Accelerator, Mass., U.S.A. | 1961 | 6·0 | strong | .. |
| Electron Accelerator, Hamburg, Germany | 1963 | 6·0 | strong | 600 ,, |
| 2 Mile Linear Accelerator, Stanford, U.S.A. | 1966 | 1st stage 10–20 BeV final 20–45 BeV | .. | 50 crores |

Conference. All of these are synchrotons. (As is well known, *synchrotron* is the name given to an accelerator in which a ring magnet is used and the orbit is kept constant by increasing the value of the confining magnetic field during the acceleration cycle.) Further, all these machines except the Cornell Electron Machine are "weak focussing" machines. It may be useful to explain the difference between a "weak focussing" and a "strong focussing" or, which is the same thing, an "alternating gradient" synchrotron. In the conventional "weak focussing" synchrotrons the radial and vertical focussing of the beam is achieved by providing a small radial decrease in the magnetic field with increasing radius. If the field varies as :—

$$B_z = B_{z0} \left(\frac{r_0}{r}\right)^n$$

with radius, where $r_0$ is the radius of the equilibrium orbit and $B_{z0}$ the field at the equilibrium orbit, then $n$ is called the "field index". It can be shown that both radial and vertical focussing can be achieved only if $0 < n < 1$. This condition on $n$ limits the maximum focussing to values such that the free oscillation wavelengths of the orbit are longer than the orbit length and amplitudes are rather large. On the other hand, in the newer machines one provides very large field gradients but the alternate magnet segments are made to have opposite signs of this gradient. This is the so-called "strong focussing" principle which was discovered independently in Greece and in U.S.A. Qualitatively this set-up corresponds to having a series of converging and diverging magnetic lenses for each transverse co-ordinate. Such a sequence was shown to be converging for both the radial and the vertical displacements. Further, the frequency of oscillation about the equilibrium orbit is higher and the amplitudes lower than for a field of constant gradient. As a result, the vacuum chamber can be made narrower and

the magnet size can be reduced to one-fifth or one-tenth that for constant gradient machines. This is a very significant development for the future of high energy synchrotrons. The principle of strong focussing can best be illustrated by taking an analogy from lens optics. For two thin lenses of focal length $f_1$ and $f_2$ separated by a distance $t$, the combined focal length F is given by: $1/F = 1/f_1 + 1/f_2 - t/f_1 f_2$. If one of the lenses is converging and the other diverging, *i.e.*, if $f_1 = -f_2 = f$ then $F = |f|^2/t$ *i.e.*, the combination is converging.

The first proton synchrotron which has used the strong focussing principle is the CERN 25 BeV machine. Just at the time of the Conference, on the night of September 16, to be exact, protons were brought once around the orbit. Since then news has been received that a workable 24 BeV beam has been available from November, 1959.

Quite a few sessions of the Conference were devoted to new principles of acceleration and consideration of some of the problems of acceleration technology. One or two of the proposals seem to be of immediate physical interest. When a nucleon of energy $\gamma$, in units of its rest mass, collides with a nucleon at rest, the energy available for creation of new particles in the centre of momentum system (C.M.S.) of the two particles is $2(\bar{\gamma} - 1)$ where $\bar{\gamma}$ is given by the relation: $\gamma = 2\bar{\gamma}^2 - 1$. So, for an "available energy" of $\sim 50$ Bev one has to have a collision of a nucleon of nearly 1,300 BeV with a nucleon at rest. On the other hand, one could have the same "available energy" in a collision of two protons of 25 BeV each moving in opposite directions. The new 25 BeV proton synchrotron at CERN has a ring circumference of about half a kilometer. On the other hand, a 1,300 BeV synchrotron with the same peak magnetic field ($\sim 14{,}000$ gauss) will have a circumference of nearly 25 km.! This, briefly, is the motivation for the study of the so-called "colliding beam" machines. Two different approaches for achieving colliding beams were reported. One follows a study by Ohkawa (there is a similar study by Pelukhov in U.S.S.R.) according to which an FFAG (Fixed Field Alternating Gradient) machine can be used to accelerate protons in two directions and build up high beam currents in both directions. Most of the work in this direction is being done at the MURA laboratories in U.S.A. and was reported by Symon and Jones. They were already building a small machine to accelerate electrons to 38 MeV each way. This machine was reported to be almost ready for operation at the time of the Conference. Results of a design study of a two-way 10 BeV FFAG proton accelerator were given. According to these, beam currents of the order of 1,000 amps. and current densities of the order of 470 amps./cm.$^2$ were visualised. It was expected that, in terms of effectiveness for nuclear interactions, this machine will be equivalent to a 250 BeV machine giving $10^{10}$ particles per pulse.

Another method of obtaining beam collisions, discussed mainly by O'Neill from Princeton, would use an existing machine to fill two intersecting magnetic storage rings. High beam currents can be stacked in the storage rings and studies indicate that it is quite feasible to obtain a good signal to background ratio at conventional values of residual pressures. Some designs of intersection rings were indicated. For example, one could make the two rings pear-shaped and thus obtain *six* interaction regions. Each interaction region can be made to have dimensions of the order of a few centimeters long and a few millimeters high. One colliding ring facility is already being built at Stanford to go with the existing Stanford Linear Accelerator for electrons. This machine is expected to start working towards the end of 1960. It is hoped that within a short operation period it would give sufficient information on electron scattering to push down the limits of validity of Quantum Electrodynamics to distances of the order of $\cdot 04 \times 10^{-13}$ cm. The present limit is $0{\cdot}8 \times 10^{-13}$ cm.

There was some discussion, but no agreement, on the relative merits of the two-way FFAG and the "two storage rings and an existing machine" system. The cost of a two-way FFAG is much greater than that of two storage rings, but it may be less than that of the storage rings *plus* a machine. Of course, supporters of the storage ring argue that in many cases one does not need to build a new machine. One visualizes that both techniques will be used in the future. Thus it became quite clear that given sufficient scientific motivation, it should be possible, within the next few years, to achieve effective energies in the range of $10^{12}$ ev.

Of course it is not very useful to go to higher energies unless one knows how one is going to use them. As energies go up the problems of working increase. Mass separation of particles becomes more difficult, the energies are virtually impossible to measure, the number of possible channels for reactions increase and generally the interpretation of the associated nuclear phenomena is greatly confused. There was only scattered discussion on some of these problems.

One distinct branch of accelerator technology deals with production, transport and separation of particle beams ("Beamology"). One ambition of all accelerator builders (or users) is to take out an "external beam". This is trivial for a linear accelerator but not so for a multi-BeV synchrotron. So far this has been achieved only for the Cosmotron. The internal beam is made to pass through a thin target near the peak of the acceleration cycle; the resulting ionisation loss deflects the beam into a magnetic groove which bends it out. Similar arrangements (called Piccioni arrangements) were discussed for the other machines.

The secondary beam arising from the impact of the internal proton beam with a target inside the synchrotron contains a large species of particles. The least abundant amongst them are, by definition, the most important. At present the best mass separation is achieved at the Berkeley Bevatron by using a system of crossed electric and magnetic fields. The system may be tuned, for example, for negative K-particles or for antiprotons and enhance by a large factor the ratio of these particles with respect to $\pi$-mesons which are most abundant at source. The latest figures quoted for Berkeley were :—

$$\text{At } 1{\cdot}17 \text{ BeV/c} \begin{cases} \bar{K} : \pi : \mu = 100 : 8 : 100 \\ \bar{P} : \pi : \mu = 100 : 20 : 180 \end{cases}$$

and

$$\text{At } 2{\cdot}8 \text{ BeV/c} \quad (\bar{P} : \pi : \mu = 100 : 150 : 230$$

Most of the background is due to $\mu$-mesons arising from the decay of $\pi$ and K-mesons during their long time of flight through the separator.

New systems of mass separation are being developed both in U.S.A. and U.S.S.R. These are the so-called R.F. separators. The basic principle is to impress velocity dependent forces dispersing on a uni-momentum beam of particles. This can be done, for example, by a travelling electric field which keeps in phase with particles of a selected mass. Some designs of such systems were discussed.

The second part of the Conference was concerned with experimental apparatus. The most fashionable, and also the most productive instrument for high energy physics these days is the bubble chamber. By now bubble chambers have been made which use Liquid Hydrogen, Helium, Propane, Freon, Methyl-Iodide loaded Propane and Xenon. This covers a wide range of media in terms of stopping power and detection probability for different radiations. All these chambers have been operated in magnetic fields. The emphasis for sometime has been on size. Reports were presented on some of these intruments. Berkeley has had a 6 ft. long liquid hydrogen bubble chamber in operation for some time. To give an idea of the cost of these instruments it may be mentioned that this bubble chamber along with the special building needed to house it cost one crore of rupees. Brookhaven National Laboratory has an 80 in. long chamber under construction. CERN at Geneva will be having shortly a large hydrogen bubble chamber 2 metres long. In Alikhanian's laboratory in Moscow, a 600 litre Freon bubble chamber has already been constructed and tested.

A new instrument which has been undergoing development very fast is the "Luminescent Chamber" (also known as Scintillation Chamber). At this Conference it became quite clear that very soon luminescent chambers will emerge as usable, and for some applications, vastly superior recording devices. The problem of modern high energy experimental physics is the problem of inducing very rare types of reactions and the allied problem of identifying these reactions in the complicated jumble of all the rest. Therefore, one would like to use high initial intensities for causation and a triggered visual device for observation. Smaller the sensitive time, smaller will be the background. The sensitive time of luminescent chambers is of the order of a microsecond or less. This is the main advantage of liminescent chambers over other visual recording instruments. There is of course the additional feature that events in the chamber can be made to announce themselves electrically. Physically a luminescent chamber is a piece of scintillator with associated devices to amplify and photograph the track of a charged particle traversing the chamber. The problem, therefore, is mainly of optics and amplification. For amplification one uses "Image Tubes". Some of these have already been produced commercially. Research on the production of bigger and better tubes is the way to get bigger and better chambers. The gain of the Image Tubes in existence is of the order of 10-100 while one needs a gain of about $10^5$ to make the tracks photographable. Therefore, one has to use multistage tubes—or several of them in cascade. Upto now most of the success has been achieved in working with the so-called Filament Chambers. These are blocks woven out of plastic scintillator filaments of diameter about ½ millimetre; the advantage of filament construction is that light is piped out to the surfaces of the block with comparatively little loss. Such chambers are being constructed at Princeton, M.I.T. and Ann Arbor and will be

used for actual experiments in the near future. In order to illustrate the use of these chambers it may be worthwhile mentioning an experiment planned by the M.I.T.-Brookhaven group to measure the magnetic moment of $\Lambda^\circ$.

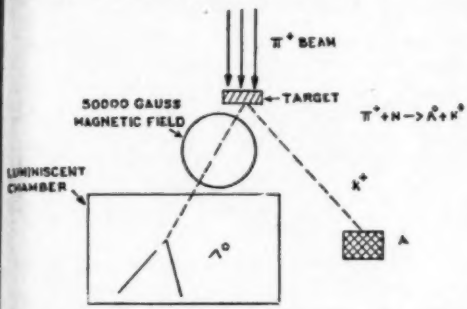



FIG. 1. Schematic lay-out for an experiment to measure the magnetic moment of $\Lambda^\circ$ (M.I.T.-Brookhaven group).

Schematics of the experiment are as shown in Fig. 1. A strong beam of $\pi^+$-mesons hits a target. Some of the interactions will be of the type: $\pi^+ + N \rightarrow \Lambda^\circ + K^+$. Detection of a $K^+$ in detector A is made to trigger the luminescent chamber. $\Lambda^\circ$s decaying in the chamber have to traverse a magnetic field of 50,000 gauss which will cause them to precess at a rate corresponding to their magnetic moment. A study of the decay asymmetry of $\Lambda^\circ$s decaying in the chamber, with and without the magnetic field, will indicate the amount of precession—and hence the magnetic moment. It is required for the experiment, of course, that the production reaction can polarise $\Lambda^\circ$s. Without a luminescent chamber this will be a very difficult experiment to do indeed.

Another instrument which has been developed is the high pressure gas Cerenkov counter. Along with momentum analysis these counters have been used for distinguishing masses. Both threshold and differential counters have been utilised. Some of the gases employed are $CO_2$, Air, $SF_6$, Freon and a gas by the code name of FC 76. For an FC 76 differential counter used by the M.I.T. group at Berkeley the refractive index can be varied continuously from 1·00 to 1·28. At 2·6 BeV/c excellent resolution has been obtained between protons, K-particles and $\pi$-mesons. It is inevitable that with energies of particles going up, gas Cerenkov counters will find increasing use in laboratories.

There were two talks on suitable transistor circuits for high energy physics work. The general impression seemed to be that very soon most, if not all, of the nuclear physics circuitory will be transistorised. Reliability of these circuits has been tested in actual experiments.

A significant part of the Conference was devoted to a discussion of procedures and techniques for automatising picture evaluation and data handling. Importance of automatisation cannot be questioned when the problems require screening and measurement of thousands of pictures, as most of the problems now do. Justification is made not only from the point of view of speed but also of accuracy. To give an idea of the efficiency of some of the evaluation procedures, using special "digitised" measuring tables and high speed computers, it may be mentioned that it takes only a few minutes to analyse a typical associated production event in a bubble chamber. The analysis would include spatial reconstruction, ranges, energies coplanarity fits, curvature measurements, compatibility fits for several given hypotheses, evaluation of errors, etc. A similar job done without automatisation would certainly take one or two man days and then too what a pain—as only those who have done this sort of thing for a hundred events can realize. One expects that quite soon it may be possible to acquire one of such analysis machines commercially, though they inevitably go with computers. One aspect of automation which has not been tackled so far is the picture scanning. It may take fifteen minutes to half an hour to find an event and only five minutes or less to analyse it! For example, one Frankenstein—that is the name given to the Berkeley bubble chamber analysis machine—needs at least four scanning tables to keep it busy. Some attention is now being given to achieve pattern recognition by a computer. Considering the complexity of reactions it is by no means a simple affair. There was also some mention of trying to teach the computer by "pandemonium". Actually one wonders if it is sensible to photograph the events on film first and then go through the slow process of chewing and digesting it. Can't one "take the picture" through electronic sensing elements and feed the information directly into an intelligent computer? May be in a few years photographic recording will be exclusively confined to passport and wallet pictures!

One can, however, become over-enthusiastic about automatisation. Automatic measurement and analysis is certainly not called for in each and every problem. Writing and testing a programme for a computer may, in some cases, take longer than doing the problem otherwise. But generally speaking one can say that for the first time a situation has been reached where

the analysis equipment is as complicated and as expensive as the original set-up. This may be a reflection on the inadequacy of our original instruments but that is a limitation which is not very easy to escape. In this field as in so many others, the role that high-speed computers are going to play in future cannot be over-emphasised.

## RADIOISOTOPES AID INDIAN AGRICULTURAL RESEARCH

AN international training course in the use of radioisotopes in agricultural research now being held in New Delhi (20 January to 17 February) under the joint auspices of the Indian Ministry of Food and Agriculture, the International Atomic Energy Agency and the UNESCO South Asia Science Co-operation Office, highlights recent progress made in this specialist field by scientists and research workers in India and other South Asian countries.

As a pioneer in atomic energy research in Asia—and as a great agricultural country—India has been giving special attention to this subject for several years, and the application of nuclear aids to agriculture is being studied in detail at the Agricultural Research Institute in New Delhi. A special laboratory, called the Radiotracer Laboratory, started functioning at the Institute in 1955 and since then a number of soil and fertilizer problems have been investigated and significant advances made in the sphere of plant breeding.

Radioisotopes are essentially by-products of work in atomic energy. Their research value is due, primarily, to the fact that they can be traced easily by their radioactivity. They give off radioactive "sparks" which can be detected with the help of special equipment, as they move through a plant, for instance, or through the body of an animal. In the same way, their progress can be followed in chemical, biological or industrial processes.

An interesting application of this "tracer" technique has been the basis of experiments undertaken at the Indian Agricultural Research Institute, on the use of fertilizers for paddy crops. The Institute's scientists have proved that the maximum uptake of phosphorus occurs when phosphate fertilizers are applied to paddy plants at ground level. It was also revealed that there was very little movement of phosphorus in soils, the usual range being from 1/8th inch to 2 inches.

An important aspect of the paddy experiments is in relation to the role of fertilizers as a direct means of raising agricultural production. The research should help agriculturists to make the most effective—and the most economic—use of the available fertilizer resources for paddy cultivation, which in India alone covers some 80 million acres.

Besides this work with tracers, Indian agricultural scientists are employing atomic aids to induce plants to change their habits and properties. At Trombay the effect of radiation on biological cells has been applied, for example, to explore the possibility of inducing early flowering of paddy.

At the Agricultural Institute in New Delhi, favourable mutations have been induced in wheat and some other plants. The Institute first developed a type of wheat resistant to black, brown and yellow rusts. But it had no awns. Indian farmers prefer the awned varieties in the belief that the "beards" prevent—or at least reduce—damage to the grain by birds. Radioactive phosphorus and sulphur came to rescue of the scientists, producing awns by a series of quick mutations which normally would have taken many years. Radioisotope experiments have helped to turn red tomatoes redder still, the object being to enhance their appearance and, hence, their market value. In cotton, the aim has been to develop a type which will yield a better crop than the normal variety. The seeds, seedlings and flowers of tobacco, potato, and a number of ornamental plants have been treated with radioisotopes in the course of other experiments.

To extend the scope of the mutation research programme, the Institute has set up a three-acre "Gamma Garden". It is a field in the centre of which there is a powerful radioactive cobalt source which can irradiate the plants grown around it (Radioactive cobalt, or cobalt-60, is one of the most powerful radioisotopes).

Also under investigation is the sterilizing effect of radiation as applied to food preservation and storage, and as a means of controlling insect pests.

In the earlier stages of its atomic programme, the Agricultural Institute was entirely dependent on supplies of radioisotopes from the United States and the United Kingdom. But for some-time now Trombay has been making available radioisotopes to research institutions throughout the country.—(*UNESCO*).

## LIQUID FLUIDISED BED REACTOR

A WORKING model of an interesting new type of nuclear reactor—already dubbed unofficially the "Saucepan" reactor—is to be built and tested by The Martin Company, the Baltimore manufacturers of atomic, aeronautical and space-age products.

Construction of the reactor has been authorised by the U.S. Atomic Energy Commission, as part of its programme to produce different kinds of reactors that can be used to help people in all parts of the world. Officially, the reactor is described as the liquid fluidised bed reactor (LFBR).

Because of the simplicity of its construction and operation, scientists believe that the new reactor may make the production of nuclear power, and the generation of electricity by its use, simpler, safer and cheaper.

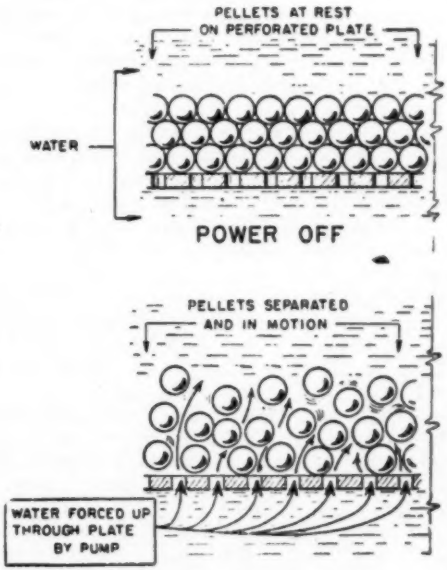
Essentially, the new reactor is a metal cylinder, similar in shape to a Saucepan, which is partly filled with pea-sized pellets of atomic fuel. The pellets contain uranium 238 and a small amount of fissionable uranium 235. The bottom of the cylinder is perforated with numerous small holes.

While the pellets lie quietly at the bottom of the cylinder, they do not produce energy. The neutrons that are continually emitted by the uranium atoms in the pellets are travelling too fast to hit other atoms properly and split them.

The "Saucepan" reactor is put into operation by forcing water up through the holes in the bottom. The water pressure forces the fuel pellets up—and apart. The water between the pellets slows down the neutrons emitted by the uranium atoms in the pellets to so-called "splitting speed", and a chain reaction begins.

The amount of the reaction, and the heat produced by it, are controlled by the amount of water that is pumped into the reactor. If the heat should become too great, the amount of water could quickly and easily be reduced by slowing down the pump that forces it into the "Saucepan".

The "Saucepan" reactor appears to be absolutely safe. If the water pressure should for some reason fail, the fuel pellets would drop to the bottom of the cylinder, thus stopping the chain reaction.




This diagram illustrates the basic principle of the Liquid Fluidised Bed Reactor which is being developed for the U.S. Atomic Energy Commission by the Martin Company of Baltimore. The fissionable fuel in the pellets can produce a chain reaction and generate heat only if the pellets are separated by a liquid moderator. Power is "turned on" when water or some other suitable liquid is forced through the hole in the bottom of the reactor vessel and separates the pellets. The water also slows down the neutrons as they are emitted by the uranium atoms.

In addition, the "Saucepan" reactor, if successful, could eliminate the need for elaborate control rods for reactors and the costly and complicated equipment that operates the rods. Control rods are used in other reactors to slow down the speed of the neutrons given off by uranium atoms. In the "Saucepan" reactor, the water does this automatically.

The concept of a fluidised bed reactor has been recognised for several years, but this is the first time that a working model has been built.—*Atoms for Peace Digest*, 19-12-1959, Vol. 4, No. 12.

# 1959 VARENNA SUMMER SCHOOL ON "WEAK INTERACTIONS"

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AN International summer school of physics is held every year in Varenna, Italy. This is organized by the Italian Physical Society and each summer various courses are given on topical and fast developing fields in physics. The lectures are held in the Villa Monastero, on the lake of Como. Eminent scientists in the field are invited to deliver courses of lectures, and students are usually selected from among the young and less experienced research workers from practically all over the world. The first summer school of this type was held in the summer of 1953.

In 1959 there were four summer schools of which one was on "Weak Interactions". This was held from June 29 to July 11. The following topics were dealt with by the various lecturers:

(1) "Symmetry properties of strong and weak interactions"—G. Lüders; (2) Survey of problems regarding the fundamental constituents of matter and their interactions; Theory of angular correlation and the $\beta$-decay of oriented nuclei —Rosenfeld; (3) Strange particle decay processes—R. H. Dalitz; (4) V-A theory—R. Gatto; (5) Relation between neutrinos, gravitation and geometry—J. A. Wheeler; (6) Theory of neutrino—B. Touschek; (7) $\mu$-decay and $\mu$-capture —J. Steinberger.

In addition to these "courses" a number of seminars on related subjects were delivered by leading experimentalists. O. Kofoed-Hansen discussed in great detail the problem of determining the coupling constants from investigations on nuclear $\beta$-decay. Various experimental methods for measuring electron and photon polarization were dealt with by H. Frauenfelder. A. Pettermann discussed the theoretical aspects of the $g$-factor of the $\mu$-meson. V. L. Telegdi reported some of his latest results on $\mu$-capture in complex nuclei and on the accurate determination of the lifetime of the $\mu$-meson. In the following paragraphs is presented the significant status of work in this field as emerged from the reports and courses given at the summer school.

The first parity experiment by Ambler, Hayward, Hoppes, Hudson and Wu was designed to test whether $\beta$-particles emitted from aligned nuclei (whose spins are lined up along an axis) were emitted preferentially in one direction or the other (along this axis). The results of this experiment using aligned $Co^{60}$ are well known; beta asymmetry was observed with the electrons going off preferentially in the direction opposite to that of the nuclear spin. The nucleus of $Co^{60}$ thus behaves like a left-handed screw or has negative helicity. So parity is not conserved in beta-decay, since right and left are distinguishable.

Since the theory of nuclear $\beta$-decay in its simplest form is a description of neutron decay, a complete experimental specification of this process alone should enable one to determine all the relevant coupling constants. In view of this, a series of experiments have been performed on the $\beta$-decay of polarized neutrons at the Argonne National Laboratory in the United States. In these experiments a collimated neutron beam was scattered at small grazing angle from a magnetized cobalt mirror; under these conditions only neutrons with spins in one direction are reflected. The angles $\theta(\vec{J}_n, \vec{p}_e)$ and $\theta(\vec{J}_n, \vec{p}_\nu)$ between the neutron spin and the electron momentum and the anti-neutrino measured. The asymmetry coefficients A and determine $p_\nu$, the proton-recoil directions were measured. The asymmetry coefficients A and B of the equations,

$$W[\theta(\vec{J}n, \vec{p}e)] = 1 + A\cos\theta(\vec{J}_n, \vec{p}_e)$$

and $W[\theta(\vec{J}_n, \vec{p}_\nu)] = 1 + B\cos\theta(\vec{J}_n, p_\nu)$ were found to be $A = -0{\cdot}11 \pm 0{\cdot}02$ and $B = 0{\cdot}88 \pm 0{\cdot}15$. From a comparison of these with the predicted values of A and B for the various possible couplings it was conclusively shown that the interaction in beta-decay is dominantly V (vector) and A (axial vector) with opposite phase relation, *i.e.*, of the type V-A. Further, using the same experimental set-up, a coefficient "D" was also measured which occurs in the term $\vec{J}_n \cdot (\vec{P}_e/E_e) \times (\vec{p}_\nu/E_\nu)$ in the electron-antineutrino angular distribution function for the beta-decay of oriented nuclei. This coefficient can be non-zero only if the beta-interaction is not invariant under time-reversal. The measured value of $D = 0{\cdot}09 \pm 0{\cdot}07$ indicates that the time-reversal invariance is valid in beta-decay (within the experimental accuracy).

Considerable additional evidence concerning the "V-A theory" of beta-decay interactions is now available from an accurate analysis of

classical beta-decay experiments like electron-neutrino angular correlations, ft-values of mirror nuclei, etc. A direct determination of the helicity of the neutrino in the electron-capture process of $Eu^{152m}$ was carried out by Goldhaber, Grodzins and Sunyar who showed that the helicity is negative. In a Gamow-Teller (GT) beta-transition, the angular momentum carried away by the two leptons is one unit. In the tensor (T) interaction, both leptons are preferentially emitted in the same direction and since the electron is left-handed the anti-neutrino must have a negative helicity. On the other hand, in the axial vector (A) case, the electron and antineutrino are emitted preferentially in opposite directions; so the anti-neutrino has a positive helicity; consequently the neutrino should have negative helicity. Since it has been found experimentally that the helicity of the neutrino is negative in the electron capture decay of $Eu^{152m}$ one clearly concludes that the beta-interaction in a GT transition is axial vector. Such a direct determination of neutrino helicity has not so far been possible in a pure Fermi transition.

A number of beta-gamma circular polarization correlation studies on mixed transitions shows that the interference between GT and Fermi transitions is the maximum possible.

The measurement of the capture cross-section for antineutrinos in an inverse beta-process has an important bearing on the two-component neutrino theory and the law of conservation of leptons. The experimental results of Cowan and Reines give the value $\sigma = (11 \pm 4) \times 10^{-44}$ cm.$^2$ is comparable to the theoretical cross-section calculated for the two-component theory. The existence of the law of conservation of leptons, together with the two-component neutrino theory demands that the rate of double beta-decay be zero and the angular distribution asymmetries have their maximum value. The observed upper limits for the rate of double beta-decay are in good agreement with the long life for this process predicted for Dirac neutrinos and strongly in disagreement with the short life expected for Majorana neutrinos ($\nu = \bar{\nu}$).

The two-component theory of the neutrino proposed by Lee and Yang, Salam and Landau and the law of conservation of leptons can account very successfully for all the experimental facts in $\pi \to \mu \to e$ decays which are relevant to these assumptions. The polarization of the negative and positive electrons from muon decays as measured by the degree of circular polarization of the bremsstrahlung and annihilation radiation or by Moller scattering conclusively shows that the positron has positive helicity and the electron negative helicity. It can then be shown, (assuming the two-component neutrino theory and the law of conservation of leptons) that the neutrinos (and anti-neutrinos) involved in the $\pi \to \mu \to e$ and nuclear beta-decay interactions are the same.

The shape of the energy spectrum of electrons from muon decays is characterized by a parameter "$\rho$" known as Michel parameter. The two-component theory of the neutrino predicts that $\rho$ is zero if the two neutral particles accompanying the decay electron are identical particles, and equal to 3/4 if one neutrino and one anti-neutrino are emitted along with the electron. Earlier experimental values of $\rho$ varied widely from 0·68 to 0·72. The latest value reported by the Columbia University group is $\rho = 0{\cdot}810 \pm 0{\cdot}025$. The deviation from $\rho = 3/4$ if true is serious; however, the trend in the measured values thus far, and the fluctuations, do not force us to assume that the deviation is serious; the measured value supports the view that a neutrino and an anti-neutrino are associated with the decay electron. Further, the energy dependence of the asymmetry co-efficient in $\mu$-decay agrees also with the predictions of the two-component theory.

The electron decay mode of the pion has been the subject of much theoretical and experimental investigation. Feynman and Gell-Mann had predicted that the branching ratio $\frac{\pi \to e + \nu}{\pi \to \mu + \nu}$ should be $1{\cdot}36 \times 10^{-4}$. Until early 1958, all attempts to detect the electron decay mode of the pion had yielded negative results and a much smaller branching ratio than the above. Recently, at CERN (Geneva) and also at Columbia, the ratio has been accurately determined and found to be in excellent agreement with the predictions of the V-A theory. The absolute rate of $\mu$-decay can also be compared with the rate of neutron decay. The close equality of the vector coupling constant in these processes was first pointed out by Feynman and Gell-Mann. Recent measurements by the Chicago group on the life-time of muons yield a value $(2{\cdot}261 \pm 0{\cdot}007) \times 10^{-6}$ sec. From the measured ft-value in the beta-decay of $O^{14}$ one gets the pure Fermi coupling constant $= (1{\cdot}41 \pm 0{\cdot}01) \times 10^{-49}$ erg-cm.$^3$ The predicted life-time of the muon using this value is $(2{\cdot}26 \pm 0{\cdot}07) \times 10^{-6}$ sec. The close agreement between the absolute magnitude of the coupling constant in beta-decay and in $\mu$-decay leads to the concept that these

weak interactions may be part of a "Universal Fermi Interaction" as had been considered in a number of earlier papers on a purely qualitative basis.

Thus classical beta-decay theory and the non-conservation of parity have together made possible a determination of the interaction constants of beta-decay. It also appears that all the weak interactions are linked together in an overall manner by the same interaction constants, the V-A type of interaction, the law of conservation of leptons and the two-component neutrino; where non-leptons alone participate in the decay process, the situation is more complex.

One should perhaps conclude by remarking how wonderful Varenna is, and the Villa Monastero in particular, for holding summer schools of this nature. An exceedingly strong tradition in this field has been built up by the Italian Physical Society through schools run by them since 1953 at Varenna. A very high level has been maintained in the atmosphere, both academic and social, of these schools. The dissemination of physics in this manner is not only fruitful but so greatly enjoyable.

## ULTRASONICALLY DISPERSED SODIUM

IT is well known that many chemical reactions involving sodium become more efficient as regards rate, yield, control, temperature conditions, etc., if the metal is used in a highly dispersed form so that the size of the sodium particles is very small and a very large surface area becomes available for reaction. The surface area of spherical particles of sodium 1 $\mu$ in diameter is $6 \times 10^4$ sq. cm. per gm. The common method of producing sodium dispersions is by stirring molten sodium and the dispersing medium together mechanically at 10,000-20,000 rev./min. when particles between 3 and 15 $\mu$ are produced.

It has been recently found that much finer dispersions of sodium in a hydrocarbon medium can be obtained by employing ultrasonic technique. Pratt and Helsby have described a simple laboratory apparatus capable of producing 200 gm. quantities of sodium dispersions by this method (*Nature*, 1959, 184, 1694). A molten mixture of sodium and the hydrocarbon dispersing medium (yellow petroleum jelly in this case), with boiling point higher than the melting point of sodium, 97° C., is contained in a pyrex cylinder (15 cm.$\times$ 6 cm.) from which air has been displaced by an inert gas. The bottom surface of the cylinder is sealed on by a "neoprene" ring to an ultrasonic magnetostrictive transducer with a resonant frequency of 25 kc./s. The mixture in the inert atmosphere is then subjected to the ultrosonic frequency for about 10 minutes till the colour of the dispersion becomes constant (deep blue, the result of scattering of light by the minute particles) indicating that the equilibrium state of the dispersion has been reached. The finished dispersion is then siphoned off, by increasing the pressure of the inert gas, into a collecting vessel, also depleted of air but containing an inert atmosphere. The sodium particles in the jelly being out of contact with air and moisture, keep well and can be safely transported. The sodium is liberated for reaction either by melting the jelly, or dissolving it in petrol.

Sodium dispersed in yellow petroleum jelly reaches an exceptionally fine state of subdivision, 1 $\mu$ or less. The superiority of the use of the ultrasonically dispersed sodium over that of the mechanically dispersed metal has been demonstrated in the exothermic reaction between sodium and chlorobenzene to produce sodium phenyl. With the ultrasonically dispersed sodium the reaction is initiated at once, even at 20° C., and the reaction rate is 10-20 times greater. Other reactions which are likely to benefit from the use of ultrasonically dispersed sodium are Claisen condensations, Wurtz reactions, preparation of sodium alkyls, aryls and alcoholates, metalations, replacement of active hydrogen atoms and the purification of hydrocarbons.

# LETTERS TO THE EDITOR

## DIPOLE MOMENT OF 2-NITRO AND 2-BROMO *PARA*-XYLENES

In dealing with the role of mesomerism in modifying dipole moments, derivatives of mesitylene and of durene have been studied, but there has not been any systematic study of the *para*-xylene derivatives except for a recent report by Kofod, Sutton, Verkade and Wepster.[1] In all the interpretations of the methyl derivatives of benzene, there is the tacit assumption that where the methyl groups are symmetrically substituted their moments cancel each other.[1,2] The *para*-xylenes provide a crucial test, since the introduction of any substituent disturbs the symmetry, while with mesitylene and durene this is not the case. That the assumption is on doubtful grounds has been already indicated by the observation that 2, 4, 6 : Tribromophenol and the corresponding tribromaniline do not indicate any cancellation of the C-Br moments. We have been studying a number of the xylene derivatives in several solvents and in the present communication the results of two of the compounds are presented.

All dipole moments have been measured by the heterodyne beat method at 32° C. and all the solvents used have been purified to spectroscopic grade and the purity checked by refractivity as well as ultra-violet spectrum. The compounds also have been purified to constant melting-point and in the case of liquids to constant refractive index. The dipole moments have been calculated by the method of Guggenheim.[3] Except for the xylene derivatives the results presented for comparison have been taken from the work of Sutton and of Smith (*loc. cit.*). These are presented in Tables I and II.

TABLE I

| Substituent | Parent hydrocarbon | | | | |
|---|---|---|---|---|---|
| | Benzene | Toluene (ortho) | *p*-Xylene | Mesitylene | Durene |
| Nitro .. | 3·97<br>4·01* | 3·72 | 4·15<br>3·91* | 3·67<br>3·70* | 3·39<br>3·62* |
| Bromo .. | 1·52 | 1·44 | 1·72 | 1·52 | 1·55 |

All dipole moments are in Debye units. Solvent Benzene.
* Values reported in Reference 1.

TABLE II

*Dipole moments in different solvents at 32° C of derivatives of* para-*xylene*

| Substituent | Solvents | | | | |
|---|---|---|---|---|---|
| | Benzene | p-Xylene | Carbon Tetrachloride | Cyclo Hexane | Dioxan |
| Nitro .. | 4·15 | 4·19 | 4·10 | 4·17 | 4·12 |
| Bromo .. | 1·72 | 1·76 | 1·70 | 1·74 | 1·86 |

We find a higher value for the moment of the xylene derivatives by about 0·2 Debye units which is well above the experimental error and the difference in mode of calculation (values of Sutton *et al.* make use of the Halverstadt and Kumler method) cannot completely account for the difference. A comparison of the infra-red spectrum of the compounds also indicates that a maximum in the series can be expected in these compounds.

Whether one uses a scale model or draws the diagrams to scale in the plane of the paper, interaction between the methyl hydrogens and the nitro, bromo and iodo group appears to be possible. Changes in moments consequent on such interaction, however, can be expected to cancel each other where the structures are symmetrical as in mesitylene and durene but in ortho-substituted toluenes and in *p*-xylenes, this is not possible. Further, while a cancellation of the methyl moments in the symmetrical unsubstituted structures is understandable, the overall moment in the substituted compounds is the resultant of the interaction of the new group with each of the methyl groups even though the dominant interaction can be with the ortho-substituent. The participation of a methyl hydrogen in hydrogen bonding cannot be ruled out and such interactions have been noticed in the X-ray study of proteins.[4]

Fuller details together with our observations on other xylene derivatives will be published elsewhere.

Chemistry Department, Madras Christian College, Tambaram,
*December* 23, 1959.

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## IMPURITY EFFECTS ON THE ANATASE-RUTILE TRANSFORMATION

CZANDERNA, RAO AND HONIG[1] have investigated the kinetics and energetics of the transformation of spectroscopically pure anatase to rutile. The infinite time temperature of the transformation was found to be $610 \pm 10°$ C. That is, below 610° C. the transformation was immeasurably slow. Recently Rao, Turner and Honig[2] have reported some observations on the effect of doped impurities on the transformation. With five-atom per cent concentration of a given impurity, the degree of stabilization of the anatase lattice was found to be in the order $Zn^{++} < Al^{+++}$ for cations and $Cl^- < SO_4^= < PO_4^=$ for anions. It was considered interesting to see whether the infinite time temperature of the transformation was also affected by the impurities. We have studied the impurity effects by differential thermal analysis using a high sensitivity apparatus similar to the one described by Pask and Warner.[3]

The pure and doped samples used in this study were prepared by methods described earlier.[1,2] The measurable sensitivity of the differential thermal analysis apparatus was about 0·25 to 0·50 cal. A constant heating rate of 12 deg. $min.^{-1}$ was employed. All the anatase samples gave small exothermic reaction peaks of about the same area, corresponding to the transformation to rutile. It was confirmed by X-ray analysis that all the samples had completely transformed into rutile after the exothermic reaction. The temperature at the beginning of the exothermic reaction peak was taken as the infinite time temperature of the transition. The results are tabulated below.

| 5 atom % impurity | Exothermic reaction Temp. ° C. |
|---|---|
| nil | 640 ± 30 |
| $Zn^{++}$ | 740 ± 30 |
| $Al^{+++}$ | 920 ± 25 |
| $Cl^-$ | 780 ± 20 |
| $SO_4^=$ | 940 ± 20 |
| $PO_4^=$ | 1005 ± 25 |

It is interesting to see that all the doped impurities adversely affect the transformation and that the relative effects of the impurities on the infinite time temperature of the transformation are in the same order as observed earlier.[2]

This work was conducted when C.N.R.R. was on the faculty of the Lawrence Radiation Laboratory, University of California, Berkeley, Calif., U.S.A.

The authors' thanks are due to Professor C. Meyer of the University of California for the use of his laboratory facilities.

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## AZO DYES AS ANALYTICAL REAGENTS FOR ALUMINIUM AND BERYLLIUM*

FACTORS governing lake formation with azo dyes and metals were systematically investigated by Morgan and Smith,[1] Elkins and Hunter,[2] and Drew *et al.*[3] These investigators deduced that aluminium does not form definite lakes with ortho-monohydroxy azo dyes but yields well-defined lakes with 0 : o-dihydroxy-azo-compounds. A pure lake is not obtained either when one of the 'OH' groups is replaced by 'COOH' or in the absence of the ortho-hydroxyls. The azo-salicylic acids did not yield pure lakes. Later studies, however, showed that the 0:0'-dihydroxy rule for lake formation with aluminium is not always obeyed. Solochrome Black 6 BFA introduced by Radley[4] as a specific reagent for aluminium is an important exception. Conditions governing lake formation with beryllium and azo dyes have not been systematically investigated. A coloured lake was obtained specifically with this metal and Diamond Black F in which only one hydroxyl group is ortho to the azo group and the molecule contains the salicylic acid unit (Brenner[5]). p-nitrobenzene-azo-orcinol which also yields similar results with beryllium contains only one hydroxyl ortho to the azo group (Komarovski and Poluetkov[6]).

* This work was carried out at the Andhra University, Waltair.

Reactions which distinguish aluminium and beryllium are scarce. The detection and determination of these metals in presence of each other is a problem of considerable interest since they occur frequently together. A set of azo dyes which possessed distinctive structural features were examined for lake formation with these two metals in an effort to determine the factors responsible for lake formation especially in the case of beryllium.

### Experimental

The salt solution (5 c.c.) containing 1 mg. of $Al_2O_3$ or BeO per c.c. was treated with an aqueous alcoholic solution of the dye-stuff. The mixture was diluted and divided into two parts. One part was treated with sodium acetate solution, boiled and filtered. The precipitate was washed free from excess dye with aqueous alcohol. The second part was treated with a slight excess of ammonia and the precipitate was filtered in the cold, washed and examined. The results are tabulated in Table I.

Table I

| No. | Reagent | Colour of lake (Al/Be) |
|---|---|---|
| 1 | *p*-hydroxy-azo-benzene | Nil |
| 2 | *p*-amino-azo-benzene | do. |
| 3 | Benzene-azo 2-hydroxy-3-naphthoic acid | Red |
| 4 | *o*-carboxy-benzene-ozo-salicylic acid | Yellow |
| 5 | Benzene-azo-$\beta$-resorcylic acid | Orange |
| 6 | Diamine brown M | Brown |
| 7 | Benzene-azo-$\beta$-napthol | Orange (Al) / Yellow (Be) |
| 8 | *p*-nitro-benzene-azo-$\beta$-naphthol | Brown-red |
| 9 | Orange II | Brown |
| 10 | Benzene-azo resorcinol | Lemon-yellow |
| 11 | Benzene-azo-*p*-hydroxy-benzoic acid | Yellow |
| 12 | Benzene-azo-salicylic acid | Pale-yellow |
| 13 | *p*-chloro-benzene-azo-salicylic acid | Yellow |
| 14 | *p*-sulpho-benzene-azo-salicylic acid | Lemon-yellow |
| 15 | *m*-tolyl-azo-salicylic acid | Yellow |
| 16 | $\alpha$-naphthalene-azo-salicylic acid | Brown |
| 17 | $\beta$-naphthalene-azo-salicylic acid | do. |
| 18 | Benzene-azo-1-hydroxy-2-naphthoic acid | do. |
| 19 | Cotton yellow R | Yellow |

p-Hydroxy-(or p-amino)-azo-benzene did not yield coloured lakes with either of the metals. Benzene-azo-$\beta$-naphthol gave an orange lake with aluminium and an yellow lake with beryllium. All the other dyes gave more or less identical results with both metals in acetate buffer as well as in ammoniacal solutions. These dyes can be grouped into three categories :—

(1) Those in which a hydroxyl or carboxyl group was present in the ortho position to the azo group in addition to the ortho-hydroxy-carboxyl group—salicylic acid unit (Diamond Black F type).[5]

(2) Those in which one hydroxyl group was in the ortho position to the azo group (Magneson type).[6]

(3) Those in which only the ortho-hydroxy-carboxyl group (salicylic acid unit) was present and neither hydroxyl nor carboxyl was ortho to the azo group.[1-3]

The results lead to the conclusion that the azo group by itself is incapable of directly chelating with these metals to yield coloured lakes. A reactive group in the ortho position to the azo group does not appear to be essential for lake formation since the simple azo-salicylic acids also yield similar results with both metals.

Chemistry Department, N. Appala Raju.
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## PREPARATION OF LEUCOCYANIDIN—(FLAV-3-ENE-3-OL)-ACETATE

In an earlier paper[1] was described the bromination of the acetates obtained from both (+) catechin and (−) epicatechin by means of N-bromosuccinimide. The products could be conveniently converted into cyanidin by boiling with alcoholic hydrochloric acid. The reaction was considered to involve bromination of the 4-position yielding the 4-bromo-catechin acetate. It was expected that the action of silver acetate on the bromo compound will lead to the formation of flavan-diol acetate. But actually the product was found to be different. It was comparatively low melting and the results of analysis of carbon and hydrogen did not agree with the requirements of a diol acetate. The infra-red spectrum was also different from that of the flavan-diol acetate obtained from Butea gum.[2] Further this product gave a good yield of cyanidin. All these results seem to be satisfactorily explained if silver acetate effected removal of hydrogen bromide and the product obtained is leucocyanidin-(flav-3-ene-3-ol)-acetate.

The above conclusion is supported by the fact that the product had a general agreement with

the one obtained by the reductive acetylation of taxifolin or quercetin and considered to be leucocyanidin-(flav-3-ene-3-ol)-acetate.[3]

*Experimental.*—The 4-bromo-epicatechin-penta-acetate[1] (0·5 g) was dissolved in absolute ethanol (60 c.c.). A suspension of finely powdered silver acetate (1 g.) in absolute ethanol (30 c.c.) was added to it slowly. The mixture was stirred continuously for 8 hours by means of a magnetic stirrer and after allowing to stand for 24 hours, filtered. Alcohol was almost completely removed from the filtrate under reduced pressure. The colourless solid (0·24 g.) which separated after diluting the alcoholic solution with water was filtered and dried. It crystallised from ethyl acetate-light petroleum as colourless tiny prisms m.p. 94–98°. It did not give any colour with alcoholic ferric chloride. On boiling with alcoholic hydrochloric acid it formed a deep-red solution (Found: C, 59·4; H, 5·2; $C_{25}H\ O_{11}$ required C, 60·2; H, 4·5%).

The 4-bromo catechin penta-acetate obtained from (+) catechin penta-acetate also yielded the same leucocyanidin-(flav-3-ene-3-ol)-acetate on treatment wth silver acetate.

*Infra-Red Spectra.*—The products obtained from both (+) catechin acetate and (−) epicatechin acetate had identical infra-red spectra in the region 2-12 $\mu$. In chloroform solution the following were the main bands in microns: 5·68 (*s*), 6·29 (*s*), 7·31 (*s*), 8·44(*s*), 8·88 (*s*), 9·52 (*w*) and 9·33 (*w*).

*Conversion into Cyanidin Chloride.*—Leucocyanidin-(flav-3-ene-3-ol)-acetate (0·5 g) was converted into cyanidin chloride following the same procedure as described earlier.[1] Yield 0·2 g. The absorption maximum in 0·1% ethanolic hydrochloric acid solution was 545 $m\mu$.

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University of Delhi, T. R. SESHADRI
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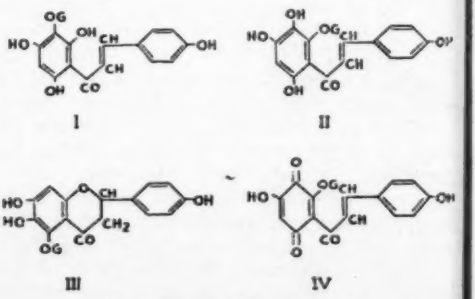
## THE COLOURING MATTER OF THE FLOWERS OF *CARTHAMUS TINCTORIUS*

EARLIER reports[1] stated that these flowers contain a useless water-soluble yellow substance and a red dye having acid properties. In the preparation[2] of carthamin paste the flowers were washed out first with acidulated water and later the dye was extracted with aqueous sodium carbonate solution. The red dye was obtained in the crystalline condition by Kametaka and Perkin[3]; Kuroda[4] found that this alcohol be crystallised in a yellow form from alcohol and she gave it the constitution of 5-glucosidoxy-2 : 4 : 4′ : 6-tetrahydroxychalkone (I). Narasimhachari and Seshadri[5] later showed that this structure was unacceptable since it would be unstable and suggested that the sugar group should be in the 2 or 6 position of the chalkone. Shimokoriyama and Hattori[6] investigated biochemically the process of reddening of yellow flower petals of *Carthamus tinctorius* and concluded that it may involve the polyphenol-oxidase or peroxidase catalysed oxidation of a leucopigment.

Seshadri[7] in his later study reported that the main component of the flowers was a yellow chalkone glycoside agreeing in composition and properties with the yellow form of carthamin and its constitution was established as 6-glucosidoxy-2 : 4 : 4′ : 5-tetrahydroxy chalkone (II). This agrees with the earlier suggestion on the constitution of carthamin. A study of the ivory-white variety of *C. tinctorius* yielded a colourless glycoside which proved to be the corresponding flavanone, *i.e.*, 5-glucosidoxy-6 : 7 : 4′-trihydroxy flavanone (III) and therefore named neo-carthamin.

A small amount of flavanone is found to be present in the coloured variety and similarly a small amount of chalkone in the ivory-white variety. Further the coloured variety, and especially the orange-red flowers, yield a red component which could be obtained in a small yield. This has the properties of a quinone and is closely related to the yellow chalkone glycoside mentioned above. It could be reduced by sulphur dioxide into the yellow compound and the latter could be oxidised by peroxidase, secured from turnips, into the red quinone, which should therefore be given the constitution of 6-glucosidoxy-4 : 4′-dihydroxy-2 : 5-quinochal-



kone (IV). A detailed study of the spectral characteristics and comparison with the pedicin group confirm this conclusion.

We have been able to get a pure sample of the red dye from the collections of late Prof. A. G. Perkin through the kindness of Prof. W. Bradley. It had been prepared from carthamin paste. It fully agrees with our sample obtained by the oxidation of the yellow chalkone.

In view of the new findings we propose that the yellow hydroxy-chalkone which is the main component of the flowers should be called *carthamin* and the red quinone dye given the name *carthamone*. The name *neo-carthamin* has already been suggested (*loc. cit.*) for the colourless flavanone glycoside. There seems to be no doubt that the yellow compound, carthamin, is the main product of the flowers and the red dye is produced by oxidation. The parallelism between this association and that of pedicin and its allies found in the leaves of *Didymocarpus pedicillata*[8] is obvious.

Department of Chemistry, Delhi University, Delhi-8, *November* 30, 1959.

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## MICA IN CUDDAPAH AND ANANTAPUR DISTRICTS

UNTIL recently, the occurrence of mica had never been reported in any of the districts of Rayalaseema in Andhra Pradesh. Neither Dr. W. King who made the first detailed geological survey of this area nor Sir Thomas Holland in his classical memoir on the mica deposits of India make any reference to it. Dr. M. S. Krishnan, under whose supervision a survey of this area was done some 10 years ago, refers only to two reported occurrences in the neighbouring districts of Chittoor and North Arcot, the first near the graveyard of the Union Mission Tuberculosis Sanatorium at Madanapalli and the second at Uchhimalai Kuppam in the Chengam Taluq. In neither case, however, does it appear that any field examination was done.

Recently, on behalf of Sri. R. Venkatasubba Reddy, M.L.C. (Andhra Pradesh), I had the opportunity of examining some occurrences in Cuddapah and Anantapur. A preliminary traverse over the area where the mica has been reported to occur and an examination of the spots themselves indicate that what are marked as undifferentiated crystallines in the geological maps of this area include extensive tracts of the Dharwar system with its typical schistose rocks and intrusive pegmatites the latter of which are not only the parent bodies of mica but also the store-houses of several of the rare minerals like pitch-blende and columbium-tantalite. The weathered outcrops of these pegmatites could be located over a number of places in the stream channels among the Seshachelam hills between the Cheyyeru and the Papaghni Rivers. The fact that these outcrops extend from near the borders of Chittoor District right into the Anantapur District seems to indicate that we have here a fairly large area suitable for mica prospecting.

Detailed prospecting of the pegmatites in the Cuddapah Disrict has already been taken in hand under my direction on behalf of Sri. R. Venkatasubba Reddy.

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## AN ALTERNATE SYNTHESIS OF γ-(2-ALKYL-4 : 5-DIMETHOXYPHENYL)-*n*-PROPYLAMINE

SHARMA AND KACHRU[1,2] prepared γ-(2-alkyl-4 : 5-dimethoxyphenyl)-*n*-propylamines (II, R = Me, Et, Pr, Bu) from the appropriate alkyl veratroles involving four steps. These amines have now been obtained from β-(2-alkyl-4 : 5-dimethoxyphenyl)-propionamides (I, R = Me, Et, Pr, Bu) by reduction with lithium aluminium hydride $LiAlH_4$ in good yields. The amides (I) have been reported earlier by Kachru and Pathak.[3]

The amide (0·01 mole) was added to a slurry of $LiAlH_4$ (0·04 mole) in dry ether at such a rate as to maintain gentle refluxing. After the addition was completed, the reaction mixture was warmed for twelve hours. The excess of $LiAlH_4$ was decomposed by the dropwise addition of water. The ethereal layer was decanted and dried over KOH. Dry hydrogen chloride was passed through the ethereal solution when the amine hydrochloride separated out. The identity of the amines was ascertained by the


(I) (II)

mixed melting-point determination with the samples obtained by the other route and also by determining the nitrogen content.

Madhav College, Vikram University, Ujjain (M.P.), *November* 9, 1959.

H. N. SHARMA.
C. N. KACHRU.

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## MICROSCOPIC DIFFERENTIATION OF CRUCIFEROUS AND NON-CRUCIFEROUS SEEDS CONTAINING MUCILAGE

THE epidermal cells of the seedcoat of cruciferous seeds invariably contain mucilage. The mucilage is present[1] in these cells around a central core. It has been shown[2] that this central core is cellulosic in nature and represents the remains of the cellulose walls which have been pushed in the centre by excessive deposition of mucilage between the mid-lamella and the primary wall. Keenen[3] observed the powdered seeds of *Brassica alba*, *B. juncea*, *B. besseriana* and *B. arvensis* under crossed nicols of a polarizing microscope and reported characteristic polarization crosses. In the present study the presence of similar crosses is reported from some cruciferous seeds in which the mucilage is deposited around a central core. A number of mucilagenous seeds belonging to families other than Cruciferæ did not show any polarization crosses. The results are recorded below :—

| Source of seeds | Family | Polarization crosses |
|---|---|---|
| *Lepidium sativum* | Cruciferæ | Present |
| *L. australianum* | ,, | ,, |
| *Brassica juncea* | ,, | ,, |
| *B. napus* | ,, | ,, |
| *B. hirta* | ,, | ,, |
| *Plantago ovata* | Plantaginaceæ | Absent |
| *P. psyllium* | ,, | ,, |
| *Linum usitatissimum* | Linaceæ | ,, |
| *Lallemantia royleana* | Labiatæ | ,, |

This confirms Keenen's finding that the polarization crosses are observed only in those species where the mucilage is deposited around a central core. This can also form a basis of differentiating cruciferous seeds. Since the appearance of polarization crosses is a property of crystalline compounds, it is suggested that the central core of the mucilage cells in Cruciferæ is composed of cellulose molecules deposited in a crystalline fashion.

Department of Pharmacy, Panjab University, Chandigarh, *October* 30, 1959.

C. K. ATAL.

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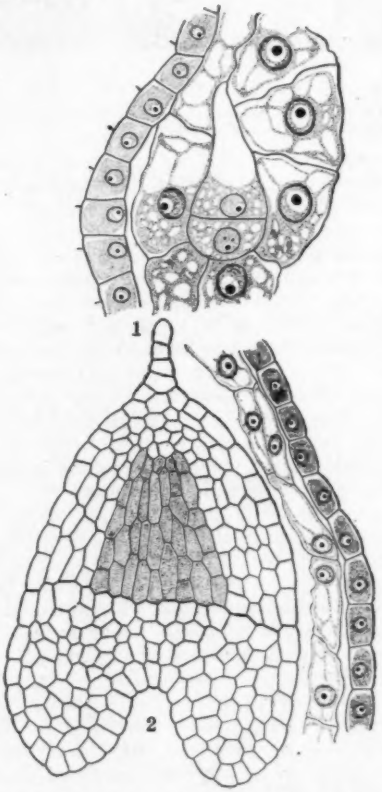
## MORPHOLOGY OF THE ENDOSPERM IN *CAESULIA AXILLARIS* ROXB.

THE seeds in the Compositæ are generally considered to be non-endospermic (Swingle, 1946 ; Lawrence, 1951 ; Rendle, 1952). Recently Maheshwari and Roy (1952) have demonstrated that a layer of endosperm persists in the mature seed of *Tridax procumbens*. According to Harris (1935) endosperm is present in *Galinsoga ciliata* as a one-celled layer, though this was later contradicted by Popham (1938). A similar layer of cells was also observed in the seeds of *Cæsulia axillaris* by the author during his studies on the embryology of this species. The development of this layer was critically studied. It was observed that it did not belong to the endosperm at all, but morphologically it represented a different tissue. The details in this connection are stated below.

The ovules in *Cæsulia axillaris* are anatropous, tenuinucellate and unitegmic. By the time the megaspore mother cell is fully developed in the young nucellus, the inner epidermis of the massive integument begins to differentiate into the endothelium and its differentiation becomes complete before the embryo-sac is fertilized. Soon after fertilization the endosperm formation commences in a cellular manner, the first and all the subsequent divisions of the endosperm nuclei being accompanied by wall formation. From the very beginning the cells

of the endosperm are poor in cytoplasm, highly vacuolated and distinct from those of the endothelium (Fig. 1). The endosperm cells continue to remain in this state during the later stages of development and in this very condition they are gradually digested away by the growing embryo. At about the stage shown by Fig. 2 the endosperm in the developing seed is represented by a layer of one or two cells with poor cytoplasmic contents, showing signs of disappearance. As the development proceeds the endosperm actually disappears before the seed matures.




FIGS. 1-2. *Cæsulia axillaris*. Fig. 1. A micropylar part of embryo-sac showing 2-celled embryo surrounded by highly vacuolated endosperm cells and a layer of endothelium. Fig. 2. L.S. of an young embryo showing an endosperm layer with poor cytoplasmic contents and a layer of endothelial cells. Fig. 1, ×733; Fig. 2, ×433.

While the endosperm is thus being consumed the cells of the endothelium continue to present a healthy appearance. To begin with, they are radially elongated but gradually during development they become elongated in the tangential direction. They also show in them the presence of starch grains later on, and they persist in the mature seed in the form of a layer surrounding the embryo. These cells with their starch contents look very much like the cells of endosperm (Fig. 2), and like the latter they also function as an organ of storage for the young embryo. Thus, this layer persisting in the mature seed of *Cæsulia axillaris* in the form of an endosperm is morphologically an inner layer of the integument which gradually develops into the endothelium and ultimately functions as an organ of storage simulating an endosperm. In the light of these findings the species in which endosperm is reported to persist needs reinvestigation. Details will appear elsewhere.

Thanks are due to Dr. L. B. Kajale for guidance and helpful criticism.

Department of Botany, P. K. DESHPANDE.
Vidarbha Mahavidyalaya,
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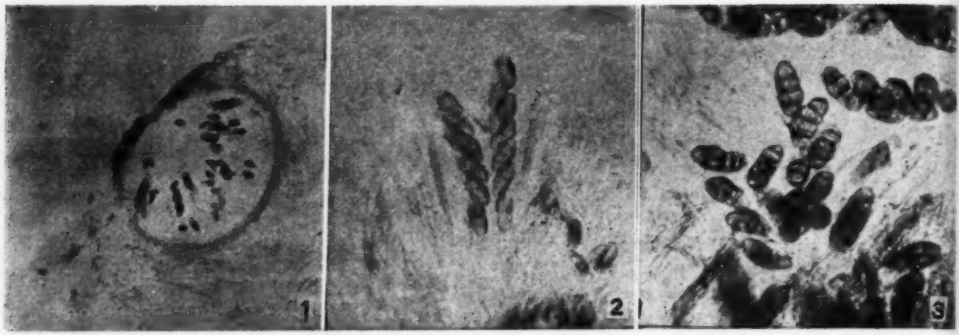
## A NEW FUNGUS ON THE LEAFLETS OF *CYCAS REVOLUTA*

WHILE studying the leaf-spot diseases at Allahabad, the authors recorded the presence of an ascomycetous fungus on the dried portions of the leaflets of *Cycas revoluta*. So far only two imperfect fungi, *viz.*, *Phyllosticta cycadina* and *Ascochyta cycadina* had been reported from this host.

The perithecia of this fungus are always separate, never aggregated, they are usually globose and black in colour. Generally they are mixed with the pycnidia of *Phyllosticta* and *Ascochyta* but can easily be distinguished on account of their superficial nature and jet black colour. Microtome sections of the host showed that only the bases of perithecia were slightly immersed in the palisade of the host (*vide* Fig. 1). The range of perithecial size varies from $108{\cdot}8\text{–}216{\cdot}7 \times 95{\cdot}2\text{–}185{\cdot}6\ \mu$ (Average $143{\cdot}6 \times 127\text{–}9\ \mu$).

Asci are long, hyaline, cylindrical with eight ascospores arranged obliquely in each ascus (*vide* Fig. 2). The ascospores are dark-brown,



FIGS. 1–3. Fig. 1. Transverse section of leaflet of *Cycas revoluta* showing a perithecium with several asci and ascospores, ×350. Fig. 2. Asci of various age with hyaline wall and obliquely arranged ascospores, ×870. Fig. 3. Some mature ascospores showing three transverse septa and one longitudinal septum, ×870.

muriform with three transverse septa and only one longitudinal septum (4 septa in all, *vide* Fig. 3). The range and average size of mature asci and ascospores is recorded below.

Asci 64–85 × 15–17 μ (average 64·65 × 16·3 μ).

Ascospores 14–16 × 5–6 μ (average 15·23 × 5·46 μ).

Detailed morphological studies were undertaken and it was concluded that the organism was some species of *Teichospora*. This genus was created by Fuckel[1] in 1870. Saccardo[2] in his first treatment divided *Teichospora* in three subdivisions: *Eu. Teichospora* with perithecia not collapsing and spores coloured; *Strickeria* with perithecia finally collapsed—concave and spores coloured and *Teichosporella* with subhyaline spores and perithecia not collapsing. The descriptions of all the known species of *Teichospora* were compared and it was found that the organism did not agree fully with any of them. It shows some resemblance with *T. œlicola* (Pass) but the asci of the present species are much shorter in length and slightly thicker in breadth. Further the spores of the present species are smaller in breadth though there is no difference in length. In *T. œlicola* the number of septa vary from 3-5 but in this fungus the mature ascospores develop four septa only. It thus appears that the present organism is some new species of *Teichospora* and it is proposed to name it as *Teichospora indica*. So far this genus has not been reported from India.

*Teichospora indica* sp. nov.—The Latin description is given below:—

Perithecia semper distincta, numquam aggregata, ut plurimum globosa et nigra, sæpe intermixta pycnidiis *Phyllostictæ* et *Ascochytæ*, a quibus tamen sat faciliter distingui potest colore penitus nigro et natura superficiei; bases tantum peritheciorum immersæ sunt in textus vallares plantæ hospitis. Asci longi, hyalini, cylindrici et octospori. Maturæ ascosporæ fusce brunneæ, muriformes, ter transverse, semel longitudinaliter septatæ. Ex morphologia patet organismum ad genus *Teichosporam* pertinere. Perithecia 108·8–216·7 × 95·2–185·6 μ; asci 65–64 × 15–17 μ; ascosporæ 14–16 × 5–6 μ.

Descriptione omnium specierum cognitarum Teichosporæ comparata, claruit nostram speciem nulli earum convenire omnibus in partibus, quare nova species esse videtur. Nulla huius generis species ex India descripta est hucusque. Nostra species *Teichospora indica* nov. spec. hic nominatur.

In order to find out its relationship with other two organisms (*viz.*, *Phyllosticta cycadina* and *Ascochyta cycadina*), numerous attempts were made to grow it at various pH ranges, different temperatures and on a number of synthetic and semi-synthetic media but the perithecia were never developed in culture. Only sterile mycelium was produced. Few perithecia were, however, produced when the organism was grown on sterilized leaves of *Cycas revoluta* but even under such conditions the conidial stages were not observed. Detailed cultural and pathological studies are in progress.

The authors are grateful to Prof. H. Santapau, of St. Xavier's College, Bombay, for translating the description in Latin and to Shri. D. D. Nautiyal for taking the photomicrographs.

Department of Botany, R. N. TANDON.
University of Allahabad, K. S. BILGRAMI.
*October* 4, 1959.

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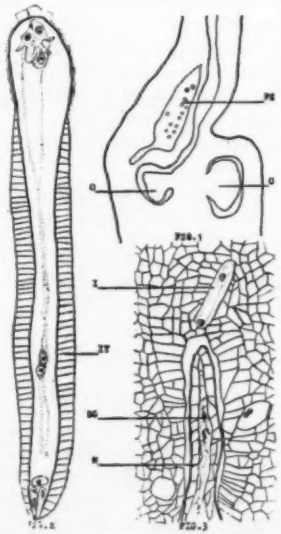
## SOME PRELIMINARY OBSERVATIONS ON THE FLORAL STRUCTURES OF OLEACEAE

THE family Oleaceae includes about 24 genera comprising four to six tribes in various systems of classification. Interrelationships within the family and with other families of Gentianales present problems worth investigating from morphological and embryological points of view. Stant (1952)[1] on anatomical basis supported the transfer of *Nyctanthes* to the family Verbenaceae as suggested by Airy Shaw (1952).[2] It is necessary to verify its validity on the embryological grounds. The present work deals with the genera *Nyctanthes*, *Jasminum*, *Schrebera* and *Olea*.

Distinct heterostylous forms occur in *Nyctanthes* and *Jasminum*. Another noteworthy feature in their morphology is the occasional occurrence of tricarpellate gynæcea and three stamens in place of the usual two. Also a part of the carpellary tissue in *Jasminum* may give rise to a pollen sac (Fig. 1).

In *Nyctanthes arbor-tristis* L. the floral organs appear in a regular sequence. The style is gynobasic. The anther wall consists of four or five layers including the epidermis. The tapetum is secretory and at places it is two layers thick. It is three layers thick on the connective side and differentiates very early. The meiotic divisions are of the simultaneous type. The pollen grain usually has three germ furrows and shows exine sculpture in the form of knob-like excrescences. The generative cell is lenticular. The pollen is shed at the bicelled stage.




FIGS. 1–3. Fig. 1. L.s. ovary showing two ovules (O) and a pollen sac (PS), ×13·33. Fig. 2. Mature 8-nucleate embryo-sac with integumentary tapetum (1T), ×110. Fig. 3. L.s. ovule with nucellus (N) and degenerating sporogenous mass (DG). Note an enlarging integumentary cell (1), ×110.

The archesporium in the ovule appears as a single cell. Rarely multiple archesporium was observed. The ovule is unitegmic, tenuinucellar and anatropous. Integumentary tapetum is also organised. The nucellus is single-layered at the micropylar end but on the sides of the embryo-sac it is two-layered. The megaspore tetrads are linear or T-shaped. The development of the embryo-sac corresponds to the normal type (Fig. 2). The synergids are hooked. The antipodals are three in number. The endosperm is cellular. The embryo has a long suspensor. The germination is epigeal. The cotyledons are long-petioled and they help in raising the plumule above the soil.

In *Jasminum* sp. the archesporium in the ovule is multicellular. Several embryo-sacs develop from the megaspores. The behaviour of the integumentary tissue is interesting. Some of its cells become multinucleate and simulate an embryo-sac (Fig. 3). Microdissections of the embryos mounted in Zirkle's medium often showed pleiocotyly. The germination is hypogeal.

Messeri (1950)[3] and King (1938)[4] have reported Scilla type of embryo-sac in *Olea europæa*. I find the same in *Olea dioica* Roxb.

*Schrebera swetenioides* Roxb. was collected from Bileshwar and Junagadh (Saurashtra). It reveals the typical one-integumented, tenuinucellate, anatropous ovule which develops an integumentary wing on the seed. Work on *Ligustrum neilgherrense* Clarke and *Linociera malbarica* Wall is under progress.

It gives me great pleasure to express my sincere thanks to Professor P. Maheshwari for encouragement and advice and to Dr. R. D. Desai for facilities.

M.G. Science Institute, N. K. PATEL.
Ahmedabad, *October* 19, 1959.

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## ORGANISATION OF CELLS IN THE AMPULLARY REGION OF THE HUMAN FALLOPIAN TUBE

THE fallopian tube in an adult female is approximately 10 cm. in length. The infundibulum opens into the wide ampulla which forms more than half of the whole tube. It narrows into the isthmus which is rounder, thick-walled and finally opens into the uterus. The tube consists of three layers. (*a*) Serous layer which is the continuation of the peritoneal layer, (*b*) muscular layer consisting of the layers of longitudinal and circular muscle fibres and (*c*) the internal or mucous layer which is continuous with the lining of the uterus. The mucous layer is thrown into many folds, plica or rugæ, which consists of the following cell types :—(1) The columnar cells with or without cilia. (2) Short columnar or cubical cells with or without cilia. (3) Goblet cells with or without cilia. (4) Thin rod-like cells with or without cilia.

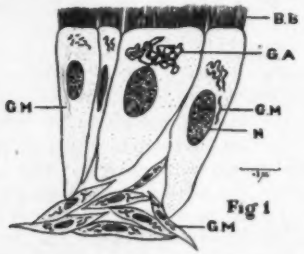

Fig 1

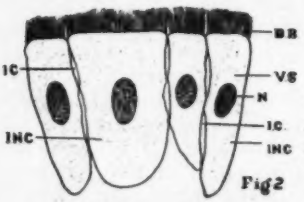

Fig 2

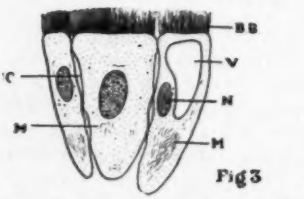

Fig 3

FIGS. 1–3. Fig. 1. Camera lucida drawings of the osmicated cells of the ampullary region. The Golgi apparatus (*GA*) is seen in the classical form in the juxta-nuclear region. Bits of Golgi material (*GM*) are also seen elsewhere in the cytoplasm. In the muscle fibres of the stroma bits of Golgi material are seen on both ends of the tapering cells. Fig. 2. Drawings of the Weigert's elastic stained cells showing the inter-cellular spaces and the intra-cellular canaliculi. The latter show a definite tendency of having connections with the inter-cellular spaces. Fig. 3. Drawings of the Iron-hæmatoxylin stained cells to show the mitochondria. The basal halves have larger concentration of mitochondria, than other regions of the cells.

*BB*, Brush border. *GA*, Reticulum of Golgi apparatus. *GM*, Bits of Golgi material. *IC*, Inter-cellular spaces. *INC*, Intra-cellular canaliculi. *M*, Mitochondria. *N*, Nucleus. *V*, Vacuole in Goblet cell.

### DISTRIBUTION OF THE CELL TYPES IN THE RUGAE

The ciliated tall columnar cells outnumber the rest of the cell types. They are everywhere on the rugæ except at the extremities farthest from the stroma. The goblet cells are intermittent between the cells on the stroma. The short columnar or the cubical cells are generally on the apical region of the plica. The rod-shaped cells are seen in between the columnar cells and the goblet cells. The cells adjacent to the muscular layer of the tube are very often devoid of cilia. The blood capillaries are seen both in the muscular layer and also in the stroma of the rugæ.

The cilia form a regular brush border. At places they seem to be of considerable length. They are dense, large and in abundance on the cells away from the fibro-muscular wall of the tube. The cells in the immediate vicinity of the fibro-muscular wall have none or short, thin and scanty cilia.

The average length of a plica varies from 1·5 to 2·5 mm., with three to six branches of varying lengths on each. The length of all cell types measure to an average of ·5 $\mu$. The width of the tall columnar cells at their broadest point measures to an average of ·1 $\mu$, the cubical cells to an average of ·25 $\mu$, and the rod-shaped cells to an average of ·05 $\mu$. The width of goblet cells is in between that of the cubical and the tall columnar cells. The nucleus in all cell types measure to an average of ·05 $\mu$ along their broad axis and, 0·1 $\mu$ along their long axis. The brush border vary in their depth from ·025 to ·05 $\mu$, and the space between the lower margin of the brush border and nucleus vary between ·1 and ·2 $\mu$.

### GOLGI APPARATUS

The classical picture of the Golgi apparatus is seen in most of the cell types, in the juxta-nuclear region. In certain cells scattered bits of Golgi material are seen in approximately every region of the cell. The reticulum of the Golgi apparatus measures to an average of ·08 $\mu$ along their long axis. In the cells of the stroma (muscle fibres) the Golgi apparatus is on both sides of the nucleus and mostly in the form of long tortuous filaments. These are

also observed in unstained cells by the phase-contrast micoscope.

INTER- AND INTRA-CELLULAR SPACES

It is evident from this study that inter-cellular spaces are present in between the different cell types. They are well marked in between the cubical and the tall columnar cells. The inter-cellular spaces appear to have connections with the spaces in the stroma. The intra-cellular spaces are mostly in the form of long tortuous canaliculi, both in cubical and tall columnar cells. They are mostly in the basal half of the cell and only occasionally adjacent to the nucleus. Often vacuolar spaces are seen in the Golgi zone of the cells. From a close study it appears that these intra-cellular canaliculi may have definite connections with the inter-cellular spaces. The intra-cellular canaliculi can be said to be Holmgren's "Saftk-anälchen" as is evident from the study of the elastic stained slides.

MITOCHONDRIA

The mitochondria are seen in various forms, i.e., like rods, dots, filaments and threads. In goblet cells mostly filamentous forms of mitochondria are seen with a larger concentration in the basal region. In cubical cells short twisted and thread-like forms of mitochondria are very common. In most of the rod-like cells the mitochondria are seen only in the apical zone. Dot forms of mitochondria are seen everywhere in every cell type.

The histochemical study for phosphatases is under progress and will be published later.

The writer sincerely thanks Dr. (Miss) Bela Saha of Bihar Medical Service, for her kind and ready co-operation in providing the material for this study.

Dept. of Zoology, R. B. SHARMA.
L. S. College, Muzaffarpur.
April 29, 1959.

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## *POLYDORA* AS AN AGENT IN THE DESTRUCTION OF SUBMERGED TIMBER

IN the extensive literature on marine boring animals there is to be found no record of an annelid capable of effecting erosion of submerged timber in the sea.

While engaged in a study of the ecology and physiology of the marine fouling and timber boring organisms along the coasts of Scandinavia, the author came across an interesting observation of *Polydora ciliata* Johnston, effecting a furrowing action on timber which together with the superficial tunnelling action of the crustacean borer *Limnoria*, caused great surface crumbling of the timber test-blocks. Since *Polydora* has hitherto not been listed under the category of wood borers, the details of the observations are presented herewith.

The author has been using straight grained planed pine blocks $15 \times 15 \times 15$ cm. for the collection of marine foulers and borers. The site of the experiment was a very interesting locality from the point of view of the ecologist. The test-blocks were suspended from the underside of the Arstad Quay at the inner end of the Puddefjord which is a part of the Bergen Harbour, where the brackish water from the lake store Lungegardsvann is flowing into the fjord.

The conditions existing in the locality offer an unusually favourable environment for the growth of tubicolous polychætes such as *Polydora* and tube-dwelling amphipods. The high turbidity prevailing in the area caused by the organic detritus is usable both for tube construction as well as an item of food. All these promoted a luxuriant growth of mat-forming organisms on the surface of the test panels. On the 19th of April 1958, while examining the blocks it was observed that among other tubicolous polychætes and amphipods, *Polydora ciliata* Johnston also has settled in fair numbers. The most interesting observation was recorded from the long-term blocks removed on 29th October, after having been in a submerged state for 9 months. There was evidence of very dense fouling, the important species that settled themselves on the blocks were *Leomeda* sp., *Bougainvilla* sp., *Balanus crenatus*, *Balgnus balanus*, *Mytilus edulis*, *Anomia squamula* and four species of Polyzoans, *Tagella unicornis*, *Aetea truncata*, *Membranipora membranaceæ* and *Bowerbankia imbricata*. But *Polydora ciliata* and other tubicolous polychætes (as yet unidentified) and amphipods formed a substantial part

of the biomass and were the most conspicuous of the fouling community. Close and careful examination of the blocks showed the presence of two well-known wood-borers, namely, *Limnoria lignorum* (Rathke), and *Teredo megotara* Hanley. It was further observed that *Polydora* had not only settled in large numbers but also had made shallow furrows (Fig. 1) on the surface

FIG. 1. Cleaned surface of a test-block to show the furrowing action of *Polydora ciliata*.

of the pine blocks on the concavity of which their soft bodies were protectively lodged. The furrowing action of these together with the progressive tunnelling of the limnoriids gave a crumbled appearance to the surface of the test-blocks. Korringal[1] who has made a detailed study of this polychæte in Bassin de Chasse at Ostend, states that a storage of suitable shelter among the scales of the Oyster's flat valve, caused by over-crowding or by the gradual crumbling away of the scales may force *Polydora* to dig into the calcareous matter in search of a more adequate shelter. The same may hold good for those larvæ of *Polydora ciliata* which have not succeeded in finding an easy place to make a mud burrow to have finally settled in some hard or smooth material like the cupped valve of an oyster where, only burrowing can offer adequate protection. In the present case the furrowing action on wood is most probably due to the mechanical abrasive action executed by the stout body bristles on the surface of the wood due to the movement of the worm in its burrow. However, the effect on the wood is remarkable. In this locality where the activity of the typical timber-borers is considerably retarded due to the heavy accumulation of the mat-forming tubicolous forms, the timber-furrowing activity of *Polydora* causing surface crumbling deserves serious consideration by virtue of its economic importance and ecological interest.

Thanks are due to Prof. Hans Brattström, Director, Biological Station, Espegrend, for the facilities given for these investigations and to the Ministry of Education, Government of India, for the award of a Fellowship during the tenure of which the present work was carried out. I express my thanks to Dr. Imanual Vigeland for the identification of the Polyzoans and to Dr. C. Stop-Borvitz of the Zoological Museum, Oslo, for the identification of the spionid as *Polydora ciliata*.

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*October* 27, 1959.

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## THE FOOD AND FEEDING HABITS OF *SELAROIDES LEPTOLEPIS* (CUVIER AND VALENCIENNES)*

WITH a view to study the food and feeding habits of *Selaroides leptolepis*, a common carangid in Indian waters, stomachs of 1830 specimens collected from the Palk Bay and the Gulf of Mannar were analysed by the Points and Occurrence methods. Examination of the stomach contents of *S. leptolepis* at different stages indicated that *Acartia*, *Oithona*, Decapod and molluscan larvæ were favourite items of food in the lower size groups and as the fish grows *Lucifer*, *Acetes*, Mysids and fishes (mostly juvenile *Anchoviella*) became more and more important in the diet. Sometimes, however, the diet exclusively consisted of either *Lucifer*, or *Acetes*, or fishes Cypris larvæ, *Centropages*, *Pseudodiaptomus* and *Corycæus* were of rare occurrence in the lower size groups and altogether absent in the higher ones. Copepod eggs and Pteropod shells were recorded only for a short while. Filamentous algæ (*Hypnea*, *Sarconema*, and *Enteromorpha*) and diatoms (*Coscinodiscus*, *Rhabdonema*, *Leptocylindrus* and *Navicula*) constituted a small percentage of the food.

Besides examining samples from the Palk Bay and the Gulf of Mannar, specimens were also obtained from Madras on the east coast and Vizhingam near Trivandrum on the west coast. *Lucifer* appendages, Mysids, *Acartia*,

* Published with the kind permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

Decapod larvæ, *Labidocera*, molluscan larvæ, Pteropod shells and fishes were recorded from the Madras specimens whereas the stomachs were practically empty in the Vizhingam specimens.

The present investigations show that *S. leptolepis* is essentially a carnivorous fish, supplementing its food with plant material. This is more or less in conformity with the observations of Chacko (1949), Datar (1954), Kuthalingam (1955 b), Chacko and Mathew (1956) and Vijayaraghavan (1957) on the food of other carangids.

The details are being published elsewhere.

Central Marine Fisheries Research Station, Mandapam Camp, *September* 30, 1959. K. K. TANDON.

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## PISTIL-LESS AND FUNCTIONAL MALE-STERILE OFF-TYPE PLANTS IN BLUE PANIC GRASS (*PANICUM ANTIDOTALE* RETZ.)

THE earhead of blue panic (*Panicum antidotale* Retz.) is a panicle comprising 2 to 3 spikelets, usually 2. In each spikelet there are two florets ; one is staminate and the other perfect.

In the indigenous Blue panic collection (I.W. 1515) from Rajasthan grown in this Division during 1958, two abnormal plants were noticed. One of them produced numerous tillers and a few panicles. On an examination of the floral parts of these plants it was found that in one plant the anthers did not extrude and remained closed inside the florets ; they did not appear to dehisce even inside the floret. However, the stigma extrusion was normal and there was some seed formation even under bagging presumably as a result of apomixis. In the case of the second plant, there was normal extrusion and dehiscence of the anthers but the pistils were totally absent and hence the plant was totally seed-sterile. The anthers in both these plants produced abundant pollen, which appeared to be fully fertile as judged by the stainability of the pollen grains with aceto-carmine.

So far as the authors are aware, occurrence of pistil-less and functional male-sterile plants does not seem to have been reported in this species.

These plants are being vegetatively propagated and the mode of inheritance of these characters is being studied. The male-sterile plant has been used for pollination with marker genes with a view to studying, among other things, the extent of apomixis in this species, as also for obtaining new hybrid combinations.

Divn. of Botany, Indian Agric. Res. Inst., New Delhi, *November* 6, 1959. A. B. JOSHI. B. D. PATIL.

## ROLE OF VITAMIN $B_{12}$ IN NITROGEN FIXATION BY *AZOTOBACTER CHROOCOCCUM*

VITAMIN $B_{12}$ is required by a variety of lactic acid bacteria such as *Lactobacillus lactis* L. leichmannii and many strains of *L. acidophilus*. Lochhead and Burton[3] showed that vitamin $B_{12}$ acted as an essential nutrilite for some of the soil bacteria. It is also synthesised by a wide variety of micro-organisms. In this laboratory it was observed that humus obtained from leguminous plant residues activated nitrogen fixation by *Azotobacter* spp. more than the humus obtained from non-leguminous plant residues.[1] Further, cobalt was found to stimulate nitrogen fixation by *Azotobacter* even at as low a concentration as 0·1 p.p.m. The beneficial effect of soil extract on activity of *Azotobacter* spp. was also observed to be destroyed by the oxidation of organic matter by $H_2O_2$. That it could be connected with the removal of vitamin $B_{12}$ was suspected by the work of Lochhead and Thexton[4,5] who found that the beneficial effect of soil extract could be observed when it was replaced by vitamin $B_{12}$. In view of the above, it was thought desirable to investigate the effect of vitamin $B_{12}$ on nitrogen fixation by *Azotobacter chroococcum*.

Jensen's medium[2] with and without molybdenum was used in the present determinations with sucrose as energy source.. The effect of vitamin $B_{12}$ at concentrations ranging from 0·01 to 0·1 p.p.m. was studied in triplicate flasks. The flasks were inoculated with one loopful of an active culture of *A. chroococcum* of 48 hours' growth. The nitrogen contents of the culture liquids were determined after 14 days of incubation at 32° C. by the Kjeldahl method.

It was observed that when vitamin $B_{12}$ was added at the above concentrations, there was significant increases in nitrogen fixation even without Mo in the medium. The increases were

comparable with those obtained with Mo alone in the medium. That it was not due to the Co in the vitamin was shown by the fact that Co alone at these concentrations gave much lower fixation of nitrogen than the vitamin $B_{12}$ though they were significantly higher than the control. Further studies on the effect of vitamin $B_{12}$ on this organism are in progress.

Grateful thanks are due to Dr. B. P. Pal, Director and to Dr. R. V. Tamhane, Head of the Division of Chemistry, for their interest in the work and for providing facilities for the same.

Indian Agric. Res. Institute, New Delhi, *December* 12, 1959.

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## THE EFFECT OF LIGHT ON TRANSLOCATION OF HYDROLYSED SUBSTANCES FROM ENDOSPERM TO EMBRYO AND INCREASE OF DRY WEIGHT IN RICE SEEDLINGS

IT is well known that hydrolysis of reserve food materials of grain starts from the very beginning of germination which brings about conversion of complex substances into simpler ones. These simpler compounds are translocated and ultimately assimilated by the growing parts of the embryo and as a result dry matter of the embryo increases. It has been revealed,[1] that the low intensity of light (continuous as well as periodic) is intimately related to the elongation of the embryo. But it is not known definitely whether such effect of light is related to the accumulation of dry matter as well.

In this experiment growth response of rice seedlings var. *Rupsail*, in terms of accumulation of dry matter and increase in length, was studied under six low intensity light regimes (125 foot candle) of different periodicities. The experiment was divided into four sets. The first one continued for 24 hours, second one for 48 hours, third one for 72 hours and fourth one for 96 hours, each was divided into six treatments with light, *viz.*, (1) Continuous dark. (2) Daily 5 minutes of light in continuous dark. (3) 19 hours of dark + 5 hours of light (Short day). (4) 19 hours of light + 5 hours of dark (Long day). (5) Daily 5 minutes of dark in continuous light. (6) Continuous light. Thus twenty-four treatments were taken in all.

The lengths and dry weights of coleoptiles, leaves, roots and grains of each treatment were recorded. The range of temperature was 32-33° C. The results are graphically represented in Fig. 1.

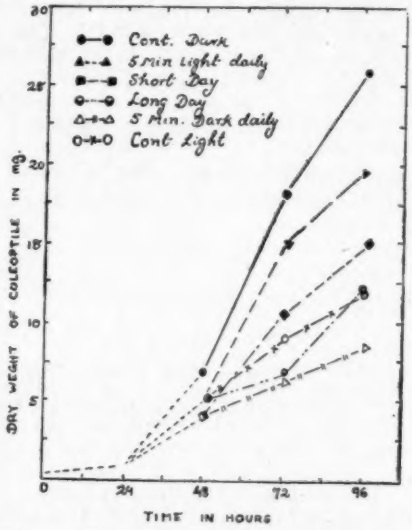


FIG. 1. Effect of photoperiods on increase in dry weight in the coleoptile of rice var. *Rupsail*.

It was revealed that at the initial stage of growth of embryo the accumulation of dry matter was parallel to the translocation from grain irrespective of light or darkness. But at the age of 96 hours a significant acceleration in the accumulation of dry matter in the seedlings was evident in continuous darkness or in short photoperiods. With the increase of length of darkness, a more or less constant increment in accumulation of dry matter, as well as increase in length of the coleoptile, was found. At the end of 96 hours, seedlings of continuous darkness accumulated 92·2 mg. of dry matter, whereas the corresponding accumulation under continuous light was only 66·2 mg. In comparison with continuous light or long photoperiod, the translocation of dry matter from the grain was more rapid under conditions of continuous darkness or short photoperiods.

Among different parts of the embryo, the coleoptile displayed the greatest contrast in accumulation of dry matter in long and short photoperiods (Fig. 1). Accumulation of dry matter in coleoptile under continuous darkness was more than double that found in continuous light. Length of the coleoptile was also greatly accelerated with increasing period of darkness.

In the second leaf, as in coleoptile, both accumulation of dry matter and growth in length was greater in continuous darkness as compared to continuous light. But in the case of the third leaf, it is interesting to note, that at the end of 96 hours a considerable amount of dry matter was accumulated in long photoperiods. It is, therefore, the reverse of what happens in coleoptile and second leaf.

In the case of root, with the increase of the length of darkness, the growth in length as well as amount of dry matter was found to be increased constantly. The values, however, are not strictly significant but a relation of constant increment also was evident.

In all the treatments light seems to have a retarding effect on the consumption of dry matter of the grain and accumulation of dry matter of the embryo as well. At the end of the 96 hours, under continuous darkness, the total consumption of dry matter from the grain was 134·6 mg. and the total accumulation in the embryo was 92·2 mg. The corresponding values under continuous light was 103·6 mg. and 66·2 mg. respectively. It was also revealed that, at any instant, the amount of dry matter consumed from the grain was considerably greater than that amount accumulated in the embryo. It is quite apparent that the balance between the two was exhausted during respiration. Under long photoperiods such balance was still greater than continuous light or continuous darkness. Further work is in progress and the results will be published shortly.

Our thanks are due to Prof. P. K. Sen, Head of the Department of Agriculture, University of Calcutta, for providing facilities for this investigation.

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Calcutta-19, *September* 30, 1959.

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## BACTERIAL LEAF SPOT DISEASE OF *DESMODIUM ROTUNDIFOLIUM* DC.

In August 1958, leaves of *Desmodium rotundifolium* growing in garden lawn and on roadside were found to have water-soaked spots surrounded by a yellow halo. In the beginning water-soaked spots of pinhead size appear on the lower surface of the leaf. Under the favourable conditions as they occur with high humidity and low temperature, these spots become visible on the upper surface and enlarge with a pale-brown centre surrounded by a yellow halo. On advancement of the disease, these spots become irregular and dark-brown in colour, measuring about 2 to 3 mm. in diameter (Fig. 1). Coalescence of the spots involving major portion of the leaf is sometimes noticed. Infection was also observed on the edges of the leaf. So far, no infection on stem and petiole has been observed.

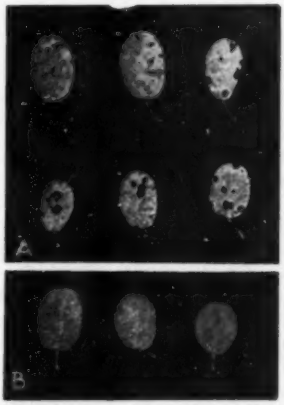


FIG. 1. A. Typical leaf spots incited by *X. desmodii-rotundifolii* on leaves of *D. rotundifolium* DC. B. Healthy leaves of the suscept.

Microscopic examination of the several spots revealed mass of bacteria oozing out from the affected tissues.

On isolation, shining yellow coloured colonies were obtained on potato dextrose agar. The cultures thus obtained were purified and inoculated on plants of *D. rotundifolium*. Typical symptoms developed on the leaves within fifteen days of inoculation.

Organisms are short rods, gram-negative, non-spore-forming, non-acid fast and motile by single polar flagellum. The size of the bacteria varies from 1·12 to 1·75 $\mu \times 0{\cdot}60$ to 0·82 $\mu$.

Colonies on potato dextrose agar are citron-yellow, circular with entire margins, smooth, convex, glistening and butyrous, odour absent and colour of the medium unchanged. Nitrates not reduced, indol and ammonia not produced. Hydrogen sulphide produced, and starch and casein hydrolysed. Gelatin and lœffler's solidified blood serum liquefied. It is a strict aerobe. Thermal death point about 53° C. Thus, from the information available, it seems that the organism under study belongs to the genus Xanthomonas.

The organism could incite spots on *Desmodium rotundifolium* DC. but not on *Cajanus cajan* Millsp.; *Cassia tora* L.; *Crotalaria juncea* L.; *Cyamopsis tetragonoloba* (L.) Taub.; *Desmodium diffusum* DC.; *D. gangeticum* DC.; *Dolichos lablab* L.; *Phaseolus aconitifolius* Jacq.; *P. radiatus* L.; *P. vulgare* L.; *Pisum sativum* L.; *Sesbania ægyptica* Poir.; *Vigna catjang* Walp.; *Gossypium hirsutum* L. and *Linum usitatissimum* L.

Since the leaf spots on *Desmodium gangeticum* and *D. diffusum* incited respectively by *Xanthomonas desmodii-gangeticii*[1] and *X. desmodii*[2] have been described, and since the organism under study is not able to incite spots either on *D. gangeticum* and *D. diffusum* it is proposed to name the organism as *Xanthomonas desmodii-rotundifolii* form novum.

Further work is in progress and will be reported elsewhere.

The authors are thankful to Rev. Father H. Santapau, S.J., of St. Xavier's College, Bombay, for rendering help in naming the organism, and to Dr. M. K. Patel for helpful suggestions.

Dept. of Plant Pathology, Institute of Agriculture, Anand, *October*, 1959.

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H. M. Shah.

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## ANTHRACNOSE DISEASE OF *DIOSCOREA ALATA* L. (YAM, ENG., RATALU, HIND.)

Ratalu (*Dioscorea alata* L.) is widely grown in the southern part of Rajasthan for its fleshy rhizomes which are used as vegetable. An extensive survey in 1958 and 1959 revealed that a very serious disease appears during the months of September and October causing great loss to the crop.

The disease appears with the brown pinhead spots on the leaves and stem. Spots on stem spread and coalesce providing a glazed black colour to it which gives a charred appearance externally. Leaf spots also coalesce (Fig. 1) and the leaves wither. During continuous rains, light-brown to dark-brown macroscopic acervuli can be observed on both leaves and stem. At the bases of lamina and petiole brown to black spots appear quickly causing shedding of leaves, which is the main characteristic of the disease. In the advanced stage, leaves and stem completely dry up resulting in total failure of rhizome formation.

Isolations from diseased material collected from different localities invariably yielded a species of *Colletotrichum* with oval to cylindrical spores.

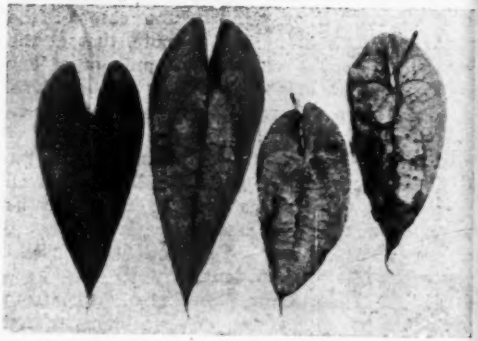

Fig. 1. (From left to right). Healthy leaf and diseased leaves showing various stages of anthracnose spots.

Pathogenicity of the fungus was tested by atomizing the spore-suspension of 15 days old culture on about two month old Ratalu plants grown in pots. All the plants were covered with bell-jar for about 20 hours, to maintain the optimum humidity for incubation. Typical anthracnose spots appeared on all inoculated plants after 90 hours, while the control plants remained quite healthy. Isolations from the inoculated plants yielded the same fungus.

*The Organism.*—The fungus grows well on 2% potato-dextrose-agar at about 25° C. with abundant sporulation.

Mycelial mat olive-green to dark-grey in colour, hyphæ hyaline to olive, guttulate, measuring 2·9 to 6·5 μ in diameter. Acervuli (Fig. 2 A) light-pink to brown, abundant,

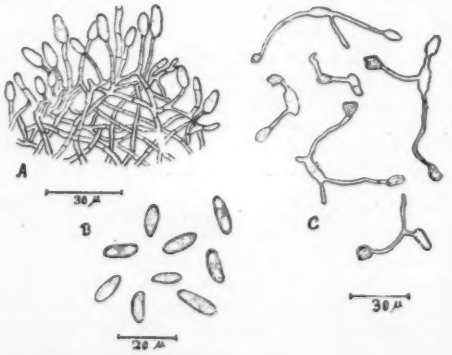


Fig. 2. A. Part of acervulus with compact mycelium, conidiophores and conidia. B. Conidia. C. Germinating conidia showing the formation of appressoria.

globose to saucer-shaped on culture media, without setæ. On leaves and stem, these are erumpent, variously shaped not uniform and disposed irregularly. Conidia (Fig. 2 B) are borne singly on conidiophores and are oval to oblong or cylindrical, 11 to 18·5 μ by 3·7 to 6·4 μ with an average of 15·6 by 4·9 μ in size, non-septate, guttulate, usually with one or two oil drops, hyaline singly but pink in masses and germinate by producing appressoria (Fig. 2 c). Conidiophores simple and hyaline.

The arrangement of conidia and conidiophores in the globose to saucer-shaped acervuli places the fungus under genera *Colletotrichum* and *Glœosporium* belonging to order *Melanconiales*. Goto (1930) reported a similar disease on *D. alata* and *D. batatas* from Formosa caused by *G. pestis* Massee which resembles with the authors' pathogen. After a detailed study, Von Arx (1957) has merged the *G. pestis* into *Colletotrichum glœosporioides* Penz. as he believes that the *Glœosporium* being a heterogenous genus should be abolished. Authors also agree with the concept of Von Arx and are therefore inclined to include their fungus under *C. glœosporioides*.

The pathogen failed to cause any infection of any host other than *Dioscorea*. Further work is in progress and will be reported elsewhere.

The authors are grateful to Shri K. L. Kothari and J. Abraham for the collection of the material and putting it at our disposal for further investigation and to Shri Samarath Raj, Director of Agriculture, for providing facilities of work.

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*October* 13, 1959.

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## CONTROL OF THE WEED *HELIOTROPIUM INDICUM* WITH MALEIC HYDRAZIDE

MALEIC hydrazide[1] has been rather extensively tested as a growth inhibitor[2–5] and a grass killer.[6,7] The present investigation is an attempt to control the growth of *Heliotropium indicum* L. (Boraginaceæ) which is a very common weed in the vegetable gardens of India. In a field experiment vigorously growing plants of approximately the same stage of growth were subjected to a foliar spray of an aqueous solution of maleic hydrazide in the concentrations 1000, 500, 250, 100 and 50 p.p.m. in separate plots. A plot was maintained without any chemical treatment as control for comparison.

After three days of spraying with 1000 p.p.m. the green colour of the healthy and full-grown leaves faded to yellowish-green. In another three days drying started at the tips and gradually proceeded downwards along the margins, and later towards the midrib and the entire leaf dried up. The young developing leaves at the tip got folded and succumbed to drying at a much shorter period while the basal older leaves took a slightly longer time to dry. Once dried, the older leaves were shed rapidly from the plants. The chemical induced an immediate arrest in the growth of the terminal and axillary meristems resulting in total suppression in growth of the main shoot and the branches. In a few cases the inflorescence appeared but the flowers did not open nor any seeds were set. So the chance of self-propagation of the plant through seeds in the same field was completely eliminated. It took nearly five weeks for the treated plants to completely dry up and die at this highest concentration.

The effects with 500 and 250 p.p.m. of the chemical were exactly the same as that of the 1000 p.p.m. except that the time required for a particular inhibitory effect to be visible was somewhat longer in these lower concentrations than in the case of 1000 p.p.m. For example it took seven and eight weeks for the plants to completely dry up in 500 and 250 p.p.m. respectively. Plants treated with 100 p.p.m. showed the adverse effects only slightly and the leaves turned pale-green and got elongated. It took a very long time for the plants to dry up.

With 50 p.p.m. however, there was little change as compared to the controls. The healthy leaves were not affected at all and normal green colour did not fade. The axillary buds grew up as usual into branches. The treated plants in fact showed a little greater luxuriance in vegetative growth as compared to the controls. The only inhibitory effect was in the shortening of the inflorescences by about half their normal length, and normal flowers were borne with usual seed setting.

Thus maleic hydrazide at certain concentrations can be effectively used to control this weed.

We are thankful to the Board of Scientific and Industrial Research, Orissa, for financial assistance to one of us (B.M.P.) and to the Naugatuck Chemical International Division of United States Rubber Company, New York, for the kind supply of the chemical MH-30.

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## PROGRESSIVE LETHAL NECROSIS IN A VARIETAL HYBRID OF COMMON WHEAT

IN the breeding programme for rust resistance in wheat in progress at Durgapura, a Research Station in Rajasthan, one cross of common wheat (*T. æstivum* L.) between a local variety R. S. 31-1 and Gabo produced F 1 seedlings that could hardly survive for four to five weeks after seeding. Gabo, an Australian variety, developed from (Gaza × Bobin 39), is a derivative of vulgare and durum parents, while R.S. 31-1 has been developed by the Department of Agriculture, Rajasthan, from the cross, Jaipur Local × C. 591.

F 1 seed was completely normal. Incidentally out of the forty crosses made during the seasons 1956-57 and 1957-58, this cross gave the highest percentage of seed-setting, *i.e.*, 40·45%. The seed after germination emerges normally and up to three to four leaf stage as in the parents. The hybrid seedling later develops more and more leafy growth and in about four weeks time, it takes the shape of a "grass clump". Leaves at this stage are smaller, stiff-pointed and brittle. The grass clumps survive for one to two weeks and then withering sets in. The withering is progressive beginning at the tips of the older leaves which get necrotic. The necrosis proceeds gradually on to the bases of the leaves. This process of necrosis, which starts with the older leaves, develops in all the leaves, and ultimately results in the total collapse and death of the plant. The stems are the last to wither. This withering was also observed in the reciprocal cross.

Since the F 1 seedling dies in the early seedling stage irrespective of which way the cross is made, the effect can be termed as 'lethal' and the condition may be called lethal necrosis. Cases of lethality and semi-lethality are of common occurrence in wide crosses, intergeneric and interspecific in wheat but their occurrence in varietal hybrids is sporadic. So far as the authors are aware, the information in this note is the first report from India. Similar cases of progressive lethal necrosis have been reported by Weibe (1934) and Caldwell and Compton (1943) where the appearance of the necrosis starts in the two-leaf stage at the tip of the oldest leaf and progressively involves the entire first, second and third leaves and an abortive fourth leaf, after which the seedling invariably dies. The difference was that necrotic seedlings did not develop into grass clumps as in the present study. McMillan (1936) has also reported a lethal condition in his wheat crosses, but the lethality is delayed until flowering time and he has described this condition as "firing", which is governed by the interaction of three complementary genes. Recently Hermsen (1957) from Netherlands has described semi-lethality in a few wheat hybrids and has suggested that two dominant complementary genes determine semi-lethality, while modifying genes are responsible for the different degrees of semi-lethality of the different F 1's.

Morrison (1957) in a recent review on 'dwarfs, semi-lethals and lethals in wheat' has made the observation that it is quite evident that some of the genes causing dwarfness are inherent in many of the Australian wheats. Incidentally the wheat variety Gabo used in our study is also an important Australian variety and lethality caused in the cross with R.S. 31-1 supports the contention of Dr. Morrison and also of many others who have used wheats like Federation, Kenya Farmer, Florance, all Australian wheat in their crossing programme, and have met with the lethal and semi-lethal conditions.

Since the variety Gabo is an important source for obtaining stem rust resistance in India, breeding programme to eliminate the lethal genes from this variety and also to study the genetic hypothesis, which involves the effect of these lethal genes, is in progress.

We express our sincere thanks to Dr. M. S. Swaminathan, Botany Division, I.A.R.I., for going through the manuscript and offering valuable suggestions.

Govt. Agric. Res. Station, Durgapura (Rajasthan), *October* 30, 1959. M. P. BHATNAGAR. P. D. BHARGAVA. S. M. GANDHI.

1. Caldwell. R. M. and Compton, L. E., *J. Heredity*, 1943, **34**, 67-70.
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## A NOTE ON PROPAGATING *CARISSA CARANDAS* BY AIR-LAYERING WITH THE AID OF GROWTH REGULATORS

*Carissa carandas* (*Karaunda*) has, so far, been propagated by seed. It is difficult to raise by cuttings. It may be propagated by inarching though it is not generally practised.

Jauhari and Nigam[1] reported 20, 30 and 40% success by using 10,000, 20,000 and 30,000 p.p.m. concentrations of IBA and IAA in lanolin paste on air-layering of *carissa* shoots. The trial was further continued to study the effectiveness of IBA and NAA mixture on rooting air-layers of *Carissa carandas*.

Twigs, which were one to two years old, green in colour, with brown streaks and an approximate diameter of 1·5 cm. (on 8 years old plants), were taken for the study. About 3 cm. wide bark was peeled off around the twigs. Upper cut of the ring was treated with different concentrations of IBA and NAA mixed in equal proportions (10,000, 7,500, 5,000 and 2,500 p.p.m. each). Control shoots were treated with lanolin paste only. Shoots thus treated were covered with damp sphagnum moss and tied firmly with plastic wrappers on 15th July.

There were ten shoots under each treatment. Six weeks later the gootees were severed from the mother plant for observations.

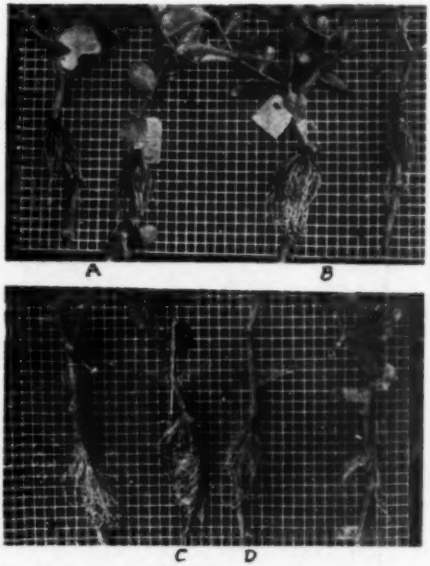
All the regulator treatments proved of considerable advantage, and cent per cent. success was achieved in the gootees (Table I).

TABLE I

*The effect of IBA and NAA mixture on rooting percentage, average number of roots per rooted gootee and length of the longest root in the air-layers of* Carissa carandas

| IBA and NAA mixed in proportions of | Rooting percentage | Average number of roots per gootee | Average length of the longest root in cm. |
|---|---|---|---|
| 10,000 p.p.m. each | 100 | 132 | 7·2 |
| 7,500 ,, ,, | 100 | 180 | 9·2 |
| 5 000 ,, ,, | 100 | 81 | 8·9 |
| 2,500 ,, ,, | 100 | 58 | 7·8 |
| Control (Lanolin only) | Nil | .. | .. |

Highest average number of roots per gootee were obtained in 7,500 p.p.m. each, concentration of the mixture (Fig. 1 *b*). Higher concentration of 10,000 p.p.m. also proved favourable (Fig. 1 *a*). While the lower concentrations induced a comparatively lower average number of roots per air-layer (Figs. 2 C and D), yet these were far superior to control which did not root at all.




FIGS. 1–2. Six weeks old air-layers of *Carissa carandas*. Fig. 1. A. 10,000 p.p.m. each, mixture of IBA and NAA. B. 7,500 p.p.m. Fig. 2. C. 5,000 p.p.m.; D. 2,500 p.p.m.

Govt. Agricultural College, Kanpur, *October* 13, 1959. O. S. JAUHARI.

1. Jauhari. O. S. and Nigam, V. N., *Allahabad Farmer*, 1958, **32**, 174.

## CHROMOSOME COUNTS IN SOME FERNS FROM NAINI TAL

THE interest in the cytology of ferns and its application to fern phylogeny is very recent.[1] With a view to compare cytologically the various Western Himalayan taxa with those of the Eastern Himalayan ones, a preliminary survey was made by the writers in Naini Tal and its nearby localities during July-August 1959.

Naini Tal proper (79·30° E, 29·23° N), with an annual rainfall of 97·04", is not rich in ferns so far as the number of species is concerned, though in the interior towards Almora quite a good number has been reported.[2] It is, however,

interesting to note that some of the species appear as regular weeds around Naini Tal, whereas the same species are somewhat rare both westwards (Mussoorie) and eastwards (Darjeeling). In the present note the haploid chromosome numbers of the species so far studied is reported (Table I). The material was fixed in 1 : 3 acetic-alcohol in the field and aceto-carmine squashes made.

The writers are indebted to Prof. P. N. Mehra for the keen interest and guidance. They are grateful to Mr. R. S. Chopra for encouragement.

Botany Department, S. C. VERMA.
Panjab University, D. S. LOYAL.
Amritsar (India), *September* 9, 1959.

1. Manton, I., *Problems of Cytology and Evolution in Pteridophyta*, Cambridge Univ. Press, London, 1950.
2. Strachey, R., *Catalogue of the Plants of Kumaon*, London, 1906.

TABLE I

| No. | Name of species* | Locality | *n*-Chromosome number | Reproduction† |
|---|---|---|---|---|
| 1 | *Botrychium lanuginosum* Wall. | Land's End | 90 | Sexual |
| 2 | *Pteris cretica* L. | Laria Kanta | '58' | Apogamous |
| 3 | *P. quadriaurita* Retz. (sens. lat.) | do | 29 | Sexual |
| | | Cheena Peak Rd. | 29 | do. |
| 4 | *Cheilanthes farinosa* (Forsk.) Kaulf. | Bhujia Ghat (Near Kathgodam) | 29 | do. |
| 5 | *Adiantum capillis-veneris* L. | Saria Tal | 30 | do. |
| | | Naini Tal | 30 | do. |
| | | Bhowali | 30 | do. |
| 6 | *A. incisum* Forsk. | Bhujia Ghat | 30 | do. |
| | | Bhim Tal | 30 | do. |
| 7 | *A. lunulatum* Burm. | Bhujia Ghat | '90' | Apogamous |
| | | Bhim Tal | '90' | do. |
| 8 | *Araiostegia pseudocystopteris* (Kze.) Copel. | Land's End | 40 | Sexual |
| | | Naini Tal | c.40 | do. |
| 9 | *Thelypteris brunnea* (Wall.) Ching | Naini Tal Bhowali Rd. | 31 | do. |
| 10 | *T. erubescens* (Wall.) Ching | do. | 36 | do. |
| 11 | *T. repens* (Hope) Ching | do. | 35 | do. |
| 12 | *Cyclosorus dentatus* (Forsk.) Ching | Bhujia Ghat | 72 | do. |
| | | Bhim Tal | 72 | do. |
| 13 | *Dryopteris chrysocoma* (Christ) C. Chr. | Land's End | 41 | do. |
| 14 | *D. marginata* (Wall.) Christ | Naini Tal Bhowali Rd. | 41 | do. |
| 15 | *D. odontoloma* (Moore) C. Chr. | Land's End | 41 | do. |
| | | Cheena Peak | 41 | do. |
| | | Laria Kanta | 41 | do. |
| 16 | *Tectaria macrodonta* (Fèe) C. Chr. | Bhim Tal | 40 | do. |
| | | Bhujia Ghat | 40 | do. |
| 17 | *Polystichum squarrosum* (Don) Fèe | Land's End | 41 | do. |
| 18 | *P. aculeatum* Sw. | Cheena Peak | 41 | do. |
| 19 | *Microsorium membranaceum* (Don) Ching | Land's End | 36 | do. |
| 20 | *Drynaria mollis* Bedd. | Cheena Peak | 37 | do. |

* All the species from each collection (locality) are deposited in the Panjab University Herbarium, Amritsar.
† Mode of reproduction is determined from spore counts. In apogamous leptosporangiate ferns a sporangium usually contains 32 viable spores in contrast to 64 in the sexual species.

## MECHANIZATION OF THOUGHT PROCESSES

THE Full Proceedings of the Symposium on "The Mechanization of Thought Processes", which was held at the National Physical Laboratory in November, 1958, are published in two volumes by HMSO for D.S.I.R., price 50 *sh.*

They contain a group of about forty related papers. In the fields of pattern recognition, learning mechanisms, mechanical translation and automatic programming, research workers of international repute have described their recent work. The discussions, in which about two hundred scientists from fifteen countries took part, occupy over one-third of the contents of the two volumes.

Some conclusions emerge from a comparison of the Proceedings with those of the Third London Symposium on Information Theory in 1955. There has been some real progress in all the fields, although satisfactory solutions to most of the problems are still some way off. One point, however, stands out. A link has been firmly established between the physicist and engineer, on the one hand, searching for new ideas on which to base new computer design, and the psychologist, on the other, seeking to understand the functioning of the human brain.

# REVIEWS

**The Dynamics of Particles and of Rigid, Elastic and Fluid Bodies.** By Arthur Gordon Webster. (Dover Edition), 1959. Pp. xii + 588. Price $ 2.38 net.

The above book has been out of print for over thirty-five years, and Dover Edition of it will therefore be warmly welcomed by physicists, engineers and applied mathematicians alike.

The book has been written in a charming and simple style, with emphasis on the physical meaning of the mathematical equations; this fact has contributed much to its popularity and has brought it a wider circle of readers than applied mathematicians only. The work is divided into three parts. Parts I and II deal with the dynamics of particles, and of rigid bodies respectively. In Part III one finds an exposition of the theory of the potential, the elasticity of solid bodies and of hydrodynamics.

The inclusion of hydrodynamics, elasticity, potential theory, and dynamics of particles and of rigid bodies—all in a single volume—makes the book a compendium of all the important branches of classical applied mathematics.

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**Advanced Calculus.** By Edwin Bidwell Wilson. (Dover Publications, Inc., New York), 1958. Pp. ix + 566. Price $ 2.45 net.

*Advanced Calculus* by Wilson is one of the most comprehensive and useful text-books in the subject. The book contains an immense amount of material, all of which is fundamental and well-presented. It can be used by graduate as well as post-graduate students of the Indian Universities, and besides it contains several chapters such as vector analysis, differential equations, calculus of variation and elliptic functions, which can serve as excellent introductions to these branches of mathematics.

The contents of the book can be classified roughly as follows: Introductory Review; Differential Calculus; Differential Equations in One and More Variables; Integral Calculus; Calculus of Variations; Infinite Series; Functions of a Complex Variable; Elliptic Functions and Integrals.

V.

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**From Microphone to Ear.** By G. Slot. Second revised and enlarged Edition. (Philips Technical Library, Eindhoven; India Philips India Ltd., 7, Justice Chandra Mehthab Road, Calcutta-20), 1959. Pp. ix + 258. Price Rs. 12.

The major portion of this book is devoted to recording of sound on discs and playing back with needle-type pick-ups which convert the mechanical vibrations of the needle into electrical quantities and subsequent amplification by electronic means. It deals with different types of pick-ups, needles and loudspeakers, amplifier circuits, the record player and changer mechanisms and cabinet and baffle design for loudspeakers. Stereophonic recording and reproduction, and magnetic sound recording are set out briefly. It is a book written with the practical aspects of the subject in the foreground and will satisfy the curiosity of amateurs in the field.

A. J.

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**Magnetic Sound Recording.** By D. A. Snel. (Philips Technical Library, Eindhoven; India: Philips India Ltd., 7, Justice Chandra Mehthab Road, Calcutta-20), 1959. Pp. xii + 217. Price Rs. 12.

Recording of sound has taken a new turn in the last decade with the development of magnetic sound recording. The basic principle of magnetic sound recording consists in transforming sound vibrations into varying currents and subsequent imprinting of this as variations in magnetisation along the length of the wire or tape made of a magnetic material. The sound thus recorded can be reproduced at will by reversing the procedure. Although in principle this does not sound complicated, in practice problems of distortion and noise arise which have to be kept at a minimum. The first step introduced to reduce distortion was the so-called D.C. biassing which has latter been discarded in favour of high frequency biassing. Further, the tape has to conform to stringent standards in respect of its thickness, uniformity of coating and should possess the requisite mechanical strength. The driving mechanism has to be suitably designed to carry the tape past the recording and play-back heads at constant speed. Further, the recording and play-back amplifiers have to be designed for

linear response over the audible frequency ranges and for compensating losses in the tape. With tape, stereophonic sound recording has been made possible with multiple track recording.

The publication under review is a fine introduction to the subject, in which every aspect briefly mentioned above is presented in a lucid manner, with a stress on the practical side. The fundamental theoretical concepts involved find brief mention and are presented in an easy to grasp manner with numerous graphs and diagrams. Numerous applications and possible applications of sound recording by the magnetic tape method are outlined. The reviewer warmly recommends this book to all those who are interested in recording and reproduction of sound.

A. J.

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**Organic Chemistry—An Outline—Problems and Answers.** By Corwin Hansch and George Helmkamp. (Published by the McGraw-Hill Book Company, Inc., New York), Pp. vi + 258.

Solving a large number of problems is the best way for the beginner to get acquainted and not feel awed by the structure, reactions and properties of organic compounds. This book drills the student to problems ranging from giving the common name of $CH_3CH_2CH_3$ to writing the structure of (2 S : 3 R)-2, 3-dichlorobutanoic acid; from the addition of hydrogen chloride according to Markownikoff's rule to those on Walden inversion and neighbouring group participation in the addition of bromine to cyclopentene; from writing the various isomers of amyl alcohol to where it would be best for Bachmann to have separated the isomers in the synthesis of equilenin.

A large number of problems are based on how to synthesise compounds and showing why "the carbonyl group is held in high esteem by the organic chemists"; and lest the imagination of the student runs away in brilliant schemes where chlorobenzene undergoes the Reimer-Tiemann reaction to yield p-chlorobenzaldehyde, the authors have introduced such questions as "Point out the errors in the following proposed syntheses". Each chapter has a good and brief review of the chemistry of the class of compounds, their syntheses and properties. The book reveals the "continuous nature of organic chemistry" by the aid of innumerable cross-references of the reactions.

Among the very few misprints are that of the "double-headed arrows" of resonance in many instances, in the answer to 15-2 c on p. 224; the problem 6-10 could be stated better. A serious error seems to be to the answer to the nice question (5-15), the correct answer being found in the text in Chapter 1-4 c. The atomic weights table is inept and could be well replaced by some physical data of use to organic chemistry problems.

The teachers of organic chemistry will find in this book problems to emphasise any aspect of the subject and of varying difficulty which can be set to students, from beginners to those at graduate level. The answers to problems are a wealth of information on the finer aspects of the behaviour of organic compounds. The student will find it as a ready reference and of use for the first few years of his study of organic chemistry. It is undoubtedly one of the best books in problems in organic chemistry.

G. B.

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**Heterocyclic Chemistry.** By Adrien Albert. (The Athlone Press, University of London), 1959. Pp. vi + 424. Price 45 *sh.*

This book is primarily intended as an introduction of heterocyclic chemistry to research workers. The author has attempted a logical approach to the subject on the basis of electron-distribution in the heterocycles.

Prof. Albert has divided the heterocycles into three main divisions, the Heteroparaffinics, *i.e.*, heterocycles having no $\pi$ bond, are treated first. Here the author establishes that saturated heterocyclic compounds have as a first approximation the same properties as "the corresponding aliphatic substances obtained by (mentally) splitting the ring at a point remote from the heteroatom". Tropine, for example, by successive splitting of two remote carbon-carbon bonds becomes a $\beta$-ethanolamine and the properties are then related (Chap. XI).

The next part of the book (pp. 39-241) deals with the heteroaromatics. In an excellent introduction (Chap. III) the author in clear language elucidates "aromatic character" in terms of the delocalisation of electrons and their partial localisation which occurs due to electrical effects of substituents; and the distribution of electron densities in various atoms or "molecular diagrams". These heterocycles are divided into two groups, *viz.*, those compounds in which there is a deficiency of electrons on the carbon atoms in the ring (Chap. VI), *e.g.*, pyridine, and those with electron excess elsewhere than on the heteroatom (Chap. V deals with compounds

having N and Chap. VI with O and S as the heteroelement), *e.g.*, pyrolle and furan. In these chapters the author after a brief introduction to the parent substances proceeds at great length to correlate the structure (primarily as the molecular diagram) of a compound to its physical and chemical properties, *viz.*, solubility, basic strengths, spectra, action of acid and alkali, the nature of amino and hydroxy derivatives, substitution by electrophilic reagents (by its very nature the discussion is short with the former group and extended in the latter) and nucleophilic reagents, addition reactions, oxidation and reduction, and free radical reactions. Each chapter deals with brief monographs of typical compounds, their use in drugs and dyes, with references till 1958 to further reading of great help to beginners in research.

Chapter VII deals with the heteroethylenics, compounds which are unsaturated without being aromatic, and the tautomerism between these and the corresponding aromatic structures have been carefully dealt with. Then follow brief chapters on spectra, ionisation constants, oxidation and reduction potentials, and dipole moments having a large amount of well-classified data of great use to research workers. In the fascinating Chap. XI complex formulæ are interpreted in terms of physical and chemical properties, and finally the author gives notes to research workers for a rational approach to syntheses (!)

This enterprisingly new approach to *Heterocyclic Chemistry* can be warmly recommended to research workers in the field of physical organic chemistry for many ideas for further work, but unfortunately organic chemists soon learn that compounds do not behave as molecular diagrams would have them.

G. B.

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**Virus Growth and Variation**—The Ninth Symposium of the Society for General Microbiology. Edited by A. Isaacs and B. W. Lacey. (The University Press, Cambridge), 1959. Pp. 272. Price 37 *sh.*

This book can be considered as a companion volume to that of the 'Second Symposium' under the title 'The Nature of Virus Multiplication' held in 1952 by the Society for General Microbiology. The interval of about 7 years has seen much progress in the field of virus research—particularly with regard to its biochemical approach. Emphasis in this book, has been laid on the virus nucleic acid with reference to viral growth and variation on one hand and viral interference and inhibition on the other. Animal viruses have received much more attention than before although bacteriophage is still held to be the model tool for virus research.

Interferon—the virus inhibiting substance, has been dealt in detail and although there is no definite information that interferon inhibits the synthesis of virus nucleic acid, it has opened up a new field for research. 13 authors have contributed a variety of articles to the symposium but the viral RNA and DNA remain to be the central theme.

The book contains valuable information and should be particularly useful to workers engaged in basic research on viruses.

V. N. K.

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**Methods of Biochemical Analysis,** Vol. 7. Edited by David Glick. (Interscience Publishers, Inc., New York), 1959. Pp. ix + 353. Price $ 9.50.

Advances have recently taken place at a phenomenal rate in different fields of biochemical research and many experimental innovations and improvements have been made in biochemical techniques that a research worker finds it necessary to consult frequently this new series of *Methods of Biochemical Analysis* edited by David Glick for the latest improved methods for conducting his investigations. The present volume under review is seventh in this series and comes up to the expectation created by the earlier volumes. Emphasis has rightly been laid on methodology as well as instrumentation since both are of fundamental importance for achieving something substantial in the field of biochemical research. Eight such articles have been written in this volume by specialists who have devoted considerable amount of time to the improvement of either the method or the instrument as the case may be.

Pierre Graeber, one of the pioneers in the field of immunoelectrophoretic analysis has compiled a very exhaustive review of this very new method which enables one to establish the minimal number of antigenic constituents of a protein mixture and to identify them by their specific reactions with homologous antibodies by superimposing the immunological reactions on a basic agar electrophoretic technique and has discussed at length the details of the technique. It is to be hoped that this review would stimulate further work in this interesting application of electrophoresis for protein detection. The analysis of alkaloidal drugs of toxicological importance has been dealt with

by A. S. Curry who has brought out in this article a much needed compilation of the various chromatographic, spectrophotometric and other methods currently in vogue.

Special mention should be made of the excellent discussion of the principles, theory and practice of the various techniques employed in the spectrophotometric analysis of translucent biological substances by Shibata. The opal glass transmission method which utilises measurements of different light adsorption is very well explained and several other transmission methods such as difference spectra, derivative spectra and the Keilin Hartree method are discussed in relation to the opal glass procedure.

The methods of estimation of inositol in biological material are well compiled and edited by J. M. McKibbin. The section on lipoprotein lipase contributed by E. D. Koru, contains a description of assay methods, preparation, etc., of this enzyme and also includes a valuable discussion of the effect of heparin on lipoproteins *in vivo*. In a later section, the determination of heparin is well discussed and the various methods extant have been critically reviewed by Jaques and Bell. The volume also contains a section on determination of creatinine and related guanidinium compounds by van Pilsum and of ethyl alcohol in tissues by Lundquist.

In all the above articles, full details have been given in a manner that will give the laboratory worker complete information required to carry out the analyses. In the end, the author index and subject index as well as cumulative indices for the volume so far published have been given. The get-up of the book is excellent and the graph and illustrations are reproduced very well. In the opinion of the reviewer, this volume is a 'must' for every laboratory worker in whichever fields of biochemistry he may be interested in.

P. S. SARMA.

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**Chloropropamide and Diabetes Mellitus.** (Annals of the New York Academy of Sciences, Vol. 74), 1959. Pp. 407-1028. $ 5.00.

The introduction of effective oval hypoglycæmic agents, particularly the sulfonyl ureas, might be considered as heralding a new era in the field of diabetes mellitus. Though the compounds at present available Tolbutamide and Carbutamide, have limited clinical use, they have focussed attention on not only new therapeutic approach but also on further researches in elucidating the etiology of diabetes, mechanism of insulin synthesis and action, the role of liver and peripheral tissues in carbohydrate metabolism and on many other facets of unsolved problems in diabetes.

This monograph deals exhaustively with the pharmacological, biochemical and clinical investigations of a new halogenated sulfonyl urea compound "Chloropropamide" [1-propyl-3-(P-chlorolo benzene sulfonyl) urea]. It may generally be concluded that this compound is more potent and long acting than the other sulfonyl ureas, but exhibits the same type of disturbing side reactions. Further studies on its effectiveness in insulin resistant and other clinical types of diabetes are essential to determine its proper sphere of usefulness.

Included in this monograph are some interesting studies on degradation of insulin-$I^{131}$ and glucogan-$I^{131}$, insulin destruction *in vivo* and on metabolic effects of insulin, chloropropamide and other hypoglycæmic agents.

M. SIRSI.

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**Advances in Enzymology**, Volume XXI. Edited by F. F. Nord, Interscience Publishers Inc., New York), 1959. Pp. 521. Price $ 12.50.

The book under review is the current one of the series of volumes edited by F. F. Nord and has eight articles dealing with recent advances in enzymology and allied subjects in biochemistry. In accordance with previous practice, one finds that the articles have been written by authors, who have themselves carried out considerable work in these specialised fields of study.

W. C. Schneider has written the first article on mitochondrial metabolism. He has traced in the beginning, historical development and then has described the identification, isolation, chemical composition and functions of mitochondria with particular emphasis on the diverse and complex role of this cellular particle. Very appropriately, the second article is by D. E. Green on electron transport and oxidative phosphorylation. Therein, Dr. Green has summarised mostly the research work of his group in the Enzyme Research Institute. His description of particles derived from mitochondria by various degradative procedures and his presentation of the electron micrographs in support of his concepts have been both lucid and convincing.

The third topic is on "The Mechanism of Metal Ion Activation of Enzymes" by B. G. Malmstrom and A. Rosenberg. This gives a very interesting account of the classification of

true metal enzymes, the kinetic interpretation of metal ion activation, complex formation of metal ions with enzymes and substrates and the mechanism and specificity of activation of metal ions. As if to supplement on the subject, there is the fourth topic written by E. Bamann and H. Trapmann, in German, on the subject of metal ion catalysed reactions, especially in the range of rare-earths, which describes several nonenzymic model reactions aimed to explain enzyme—enzyme-model reactions. The fifth review article written by J. M. Buchanan and S. C. Hartman on "The Enzymic Reactions in the Synthesis of the Purines" is an excellent document on the sequence of reactions in the biosynthesis of purines. The reader will find it most stimulating to read the sections on the mechanism of formation of carbon-to-nitrogen bonds and the role of adenosine triphosphate in synthetic enzyme reactions. The subject of pyrimidine biosynthesis has been dealt with by P. Reichard in the sixth review wherein he discusses the formation of orotic acid from carbamyl asparate and its further conversion to uridine and cytidine nucleotides. In the article on "The Biosynthesis and Function of the Carotenoid Pigments", T. W. Goodwin has described the distribution of these pigments in various photosynthetic and non-photosynthetic tissues, the biosynthesis of these pigments and the effects of oxygen, temperature, pH, inhibitors, etc., on the carotenogenesis and also the phytoene series as precursors of carotenoids. He has further discussed the functions of carotenoids in photosynthesis, photoxidation, oxygen transfer and other effects. The last topic on "Folic Acid Co-enzymes and One-carbon Metabolism" written by F. M. Huennekens and M. J. Osborn deals with certain aspects of the chemistry of folic acid and related compounds, biosynthesis of folic acid and its co-enzymes and the role of folic acid co-enzymes in intermediary metabolism involving "active formate" and "active formaldehyde".

The authors mentioned above have in a very commendable manner, given an extensive and critical account of the subjects covered by them along with adequate references to the recent literature. Editor Nord has added in the end, the cumulative indexes for Volumes I to XXI which should prove very valuable for research workers in this field. In view of the great importance of the subjects dealt with in this as well as in previous volumes of this series to biochemists in underdeveloped countries in Asia and the Far East, it will indeed be a praiseworthy effort, if the publishers were to bring out a cheap and a consolidated edition of all the volumes of *Advances in Enzymology* so far published.

P. S. SARMA.

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**Books Received**

*The Chemistry of Heterocyclic Compounds—S-Triazines and Derivatives.* By E. M. Smolin and L. Rapoport. (Interscience Publishers, New York), 1959. Pp. xxiv + 644. Price $ 30.00.

*Recent Progress in the Endocrinology of Reproduction.* Edited by C. W. Lloyd. (Academic Press Inc., New York-3 ; India : Asia Publishing House, Bombay-1), 1959. Pp. xi + 532. Price $ 12.00.

*Pigment Cell Biology.* Edited by Myron Gordon. (Academic Press Inc., New York-3 ; India : Asia Publishing House, Bombay-1), 1959. Pp. xiv + 647. Price $ 13·50.

*Subcellular Particles.* Edited by Teru Tayshi. (The Ronald Press, 15 East 26th Street, New York-10, N.Y.), 1959. Pp. viii + 213. Price $ 6.00.

*Ultracentrifugation in Biochemistry.* By H. K. Schachman. (Academic Press, Inc., New York-3 ; India : Asia Publishing House, Bombay-1), 1959. Pp. xii + 272. Price $ 8·80.

*Physicochemical Basis of the Analysis of the Paragenesis of Minerals.* By D. S. Korzhinskii —Translated from Russian. (Consultant Bureau, New York ; Chapman & Hall, London), 1959. Pp. 142. Price $ 7.50.

*The Geochemistry of Rare and Dispersed Chemical Elements in Soils.* By A. P. Vinogradov—Translated from Russian. (Consultant Bureau, New York ; Chapman & Hall, London ; India : Asia Publishing House, Bombay-1), 1959. Pp. 209. Price $ 9.50.

*A Supplement to Helium.* By E. M. Lifshits and E. L. Andronikashivli—Translated from Russian. (Consultant Bureau, New York ; Chapman & Hall, London ; India : Asia Publishing House, Bombay-1), 1959. Pp. v + 167. Price 60 *sh.*

*Recent Research in Molecular Beams.* Edited by I. Estermann. (Academic Press, Inc., New York-3 ; India : Asia Publishing House, Bombay-1), 1959. Pp. 190.

*Absorption and Dispersion of Ultrasonic Waves.* By K. F. Herzfeld, and T. A. Litovitz. (Academic Press, Inc., New York-3 ; India : Asia Publishing House, Bombay-1), 1959. Pp. xviii + 535. Price $ 14.50.

# SCIENCE NOTES AND NEWS

### Formation of Complexes Between Iodides

Dr. P. C. Sinha and K. V. Srinivasan, Department of Chemistry, Patna University, write :— The formation of the complexes, between Cadmium iodide, Zinc iodide and Mercuric iodide and the other iodides of metals of different groups of the periodic table, has been studied by different physico-chemical methods. From results obtained so far, using Job's method of continued variation as applied to the lowering of freezing-points, evidence has been obtained for the existence of two distinct complexes, one between Barium iodide and Cadmium iodide (1 : 1) and the other between Strontium iodide and Cadmium iodide (also 1 : 1). No other complexes seem to be formed in these systems. The values of the stability constants of these complexes are being determined.

### Occurrence of a Scale Insect on Betel-Vine at Tanjore

Messrs. T. R. Subramaniam, R. Jayaraja, R. V. Narasimhan and S. Ramdoss of the Crop and Plant Protection Division, Tanjore, report that a species of *Lepidosaphes* scale insect occurred in a 5-acre betel-vine crop in Rajagiri village, Tanjore District in a serious form causing shrinking and drying up of leaves and vines for the first time and that it was controlled to a great extent by spraying of Pyrocolloid 1 in 300.

### Award of Research Degree

The Gujarat University has awarded the Ph.D. Degree to Messrs. R. Sethuraman and Shri S. R. Sreenivasan for their theses entitled "A Study of Ionospheric Wind Drifts over Ahemedabad" and "The Distribution of Electrons in the Ionosphere" respectively.

The Utkal University has awarded the Ph.D. Degree in Chemistry to Shri B. K. Patnaik for his thesis entitled "Studies on Heterocyclic Sulphur Compounds".

### National Institute of Sciences of India, New Delhi-1

At the Anniversary General Meeting of the National Institute of Sciences of India held on 2nd January 1960 the following were elected to the Council for 1960 : President—Prof. S. K. Mitra (Calcutta) ; Vice-Presidents—Dr. B. P. Pal (Delhi), Prof. N. R. Sen (Calcutta) ; Treasurer—Prof. Ram Behari (Delhi) ; Foreign Secretary—Dr. B. Mukerji (Lucknow) ; Secretaries—Sri. S. Basu (Delhi), Prof. P. Maheshwari (Delhi) ; Editor of Publications—Prof. R. C. Majumdar (Delhi) ; Members of Council—Dr. K. N. Bagchi (Calcutta), Dr. K. R. Dixit (Bombay), Prof. C. S. Ghosh (Roorkee), Prof. P. S. Gill (Aligarh), Prof. B. C. Guha (Calcutta), Dr. A. C. Joshi (Chandigarh), Prof. D. S. Kothari (Delhi), Dr. B. C. Kundu (Barrackpore), Prof. R. P. Mitra (Delhi), Dr. M. A. Moghe (Nagpur), Prof. B. N. Prasad (Allahabad), Dr. Atma Ram (Calcutta), Dr. M. S. Randhawa (Delhi), Dr. J. C. Ray (Calcutta), Prof. B. R. Seshachar (Bangalore), Dr. V. Subrahmanyan (Mysore), Dr. W. D. West (Saugar).

### Indian Society of Soil Science

At the 25th Annual General Meeting of the Indian Society of Soil Science held at Bombay on the 3rd January 1960, the following were elected as office-bearers for the year 1960 and 1961 ; President—Dr. S. P. Raychaudhuri ; Vice-President—Dr. R. V. Tamhane, Honorary Secretary—Dr. T. D. Biswas.

### Building Research Workers' Conference

The Second Building Research Workers' Conference will be held at the Central Building Research Institute, Roorkee, from 11-13th April 1960.

The Conference would be limited to topics, connected with Building Materials only and will be divided into the following sections : Section I —Raw materials and product studies ; Section II —A. Special Techniques, B. Standardisation and Testing ; Section III—Manufacturing Problems ; and Section IV—Special Problems.

Further information regarding this Conference may be had from the Assistant Director (Information), Central Building Research Institute, Roorkee (U.P.).

### International Society of Tropical Ecology

The above Society with its headquarters at Allahabad, U.P., India, was inaugurated on 5th January 1960. The following office-bearers were elected for 1960-61 : President—Dr. J. C. Sen Gupta, Calcutta, Vice-Presidents—Dr. F. R.

Fosberg, Washington, Dr. C. G. G. J. Van Steenis, Holland; Treasurer—Dr. R. Misra; General Secretary and Editor-in-Chief—Dr. G. S. Puri; Secretary—Dr. Mani.

The membership forms may be had from the Secretary, Dr. G. S. Puri, Director, Central Botanical Laboratory, 10, Chatham Lines, Allahabad, U.P., India.

**Indian Botanical Society**

The following were elected as office-bearers of the society for the year 1960; President—Dr. I. Banerji, Calcutta; Vice-Presidents—Dr. E. K. Janaki Ammal, Jammu, Prof. R. Misra, Varanasi (also Hon. Librarian); Hony. Secretary—Prof. J. Venkateswarlu, Waltair; Business Manager and Hon. Treasurer—Prof. T. S. Sadasivan, Madras.

**Great Indian Rhinoceros**

The Great Indian rhinoceros, *Rhinoceros unicornis*, is one of the mammals the names of which appear on the list of animals in danger of extermination, which is maintained by the Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources. In 1958, about 800 of these rhinoceros were believed to exist, of which some 400 were known to be in India. About the same number were thought to live in Nepal, in the valley of the River Rapti. The number of this rhinoceros in India was fairly accurately known because of the interest of the Indian Government, the attention given to the species by the Indian Board for Wild Life, and especially to the work of E. P. Gee. There were about 350 rhinoceros in sanctuaries in Assam—notably 250 in the Kaziranga Wild Life Sanctuary—and 50 in Bengal. About the number of rhinoceros in Nepal no accurate figures were known. In September 1958 a message came from Katmandu to the IUCN stating that only about 35 rhinoceros remained in Nepal; the rest had been killed by poachers. The Survival Service Commission of the Union arranged for Gee to visit Nepal to investigate the distribution and status of rhinoceros in Nepal and to suggest measures for its preservation. A survey by Gee shows that the rhinoceros has not reached the levels which the message from Nepal had described, but the general picture is of declining numbers in a shrinking habitat. Gee's report has been accepted by the S.S.C. and given to the Union for appropriate action to preserve the Great Indian rhinoceros—*Oryx*, 5, 2; August 1959.

**Proton Microscope**

The French National Research Centre has released details of the first proton microscope which M. Magnan and M. Chanson, of the Laboratory for Atomic Synthesis, near Paris, have developed.

The instrument employs a beam of protons which has certain theoretical advantages over the electron beam used in an electron microscope. In spite of the very small wavelength associated with a beam of electrons, it is impossible, in practice, to correct electronic objective lenses for aberrations of the aperture and it is necessary to "stop" down the aperture of the beam source to an angle of the order of one-tenth of 1°. This leads, in turn, to errors due to diffraction, and in fact a compromise is effected between aberrations due to aperture and those due to diffraction. These are the main factors which limit the resolving powers of the best electron microscopes to dimensions of about 6 angstrom units.

Because of the much greater mass of the proton, the theoretical optimum aperture is less than half that for electrons and that where a minimum aberration for electrons was of the order of 16 AU the corresponding figure for protons would be about 1 AU. This indicated to Magnan and Chanson the theoretical basis for a microscope using protons which would have a higher resolving power than one using electrons: in the ideal case about 6 times the resolving power of the best electron microscope.

The instrument itself employs electrostatic rather than magnetic techniques. In place of the hot metal emitter for an electron source, a very high frequency oscillator is used to form a plasma of ionized hydrogen, from which the protons are accelerated through 50,000 volts to produce the beam. So far the resolution obtained with the prototype is of the order of 20 AU and work is proceeding on an improved design to approach the theoretically obtainable resolution.

The instrument is capable of showing much greater direct contrast in extremely thin sections of (for example) organic preparations than any electron microscope and it would appear to offer great promise for biological research.—*ISLO Newsletter*.

**Nuclear Magnetic Resonance Method of Studying Blood Flow Rate**

A method of measuring the rate of flow of blood in animals and human beings by using the techniques of nuclear magnetic resonance has been suggested by J. R. Singer in *Science*,

1959, 130, 1652. Experiments carried out on the blood flow in mice tails have demonstrated the feasibility of the method and its extension to determine the blood flow rates in the fingers and arms of human beings. The method consists in measuring the nuclear relaxation time of the protons in the water of the blood and then noting the apparent change in the relaxation time when the flow is temporarily stopped by the application of a tourniquet. The means of such measurements of relaxation time are known from physical investigations of the nuclei of gases, liquids and solids.

The actual procedure is to take two NMR absorption curves at R-F frequencies, one when a tourniquet is applied (non-flowing state), and the other with the tourniquet removed (flowing state). Since the flow results in less saturated nuclei entering the observation region, the absorption curve in the second case will be larger in amplitude. A simple relation has been derived connecting the blood flow rate with the heights of the absorption curves in the two cases and the static thermal relaxation time.

Since the power input involved is less than 0·01 watt of 60 Mc./s. (R-F) waves there is no danger to the subject.

### *Optics and Spectroscopy*

This new translation Journal is brought out by the Optical Society of America, Inc., with a grant-in-aid from the National Science Foundation. The Russian Monthly Journal *Optika i Spektroscopiya* of the USSR Academy of Sciences commenced publication in 1956 and publishes the work of leading Russian scientists in all branches of optics and spectroscopy. The English translation Journal starts from Vol. VI, January 1959. The aim of the Society is to bring out each number within four months of the Russian original.

The Journal which is in mimograph printing in double column, comprises of three sections: (i) articles of about 2-3 pages each embodying original research, (ii) "brief reports" giving results of investigations, and (iii) "News" items.

The January 1959 (Vol. VI, No. 1) number which has come for review is of 84 pages and contains 14 articles and 13 brief notes. These include six on luminescence and fluorescence, four on infra-red and four on Raman effect. Among the other articles of interest may be mentioned those "On he breakdown of Kramers-Kronig dispersion relations in molecular crystals" "On the theory of optical activity in crystals" and "Concentration extinction of the Luminescene of dyes in solutions". The News Section includes Reports on the VII Conference on Luminescence held in Moscow in June-July 1958, and on the International Congress on the Physics of Solids held in Brussels in June 1958.

Foreign non-member subscription for the Journal is $ 25.00 *plus* $ 3.00 for postage.

### Test-Tube Protein

The problem of joining up amino-acids chemically into proteins has been solved in a new manner by M. Bodzhansky and V. du Vigneaud of Maryland. As an example of their new method they describe the synthesis of oxytocin, a hormone of the pituitary gland, in the *Journal of the American Chemical Society* (Vol. LXXXI, p. 5688).

Most methods of making oxytocin, or any protein, use as starting material a peptide—that is, several amino-acids already linked up. However, the experiments of du Vigneaud, aimed not simply at a better way to make oxytocin but rather towards finding a way of building up long chains from amino-acids in a chosen sequence, have succeeded in doing so using a single amino-acid to start with.

The process involves many chemical steps and the necessity of maintaining between the amino-acids the same "twist" (as shown by the effect on polarized light); the molecules are only biologically active with the correct "twist" throughout.

After many trials it turned out that the best procedure was to convert the acid group of the "growing" end of the chain into the nitrophenylester. This was made to react with the amino-acid which was next to be joined; the compound formed was in turn converted to the corresponding ester, the next amino-acid added, and so on.

In this way a peptide chain can be built up and lengthened, one amino-acid at a time, until the desired protein has been synthesized—*ISLO Newsletter*.

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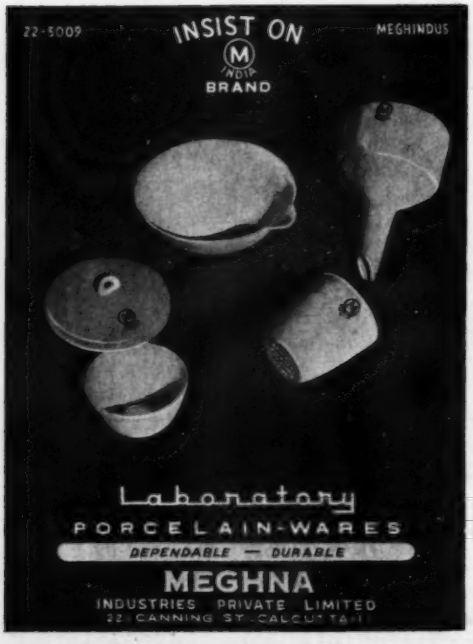


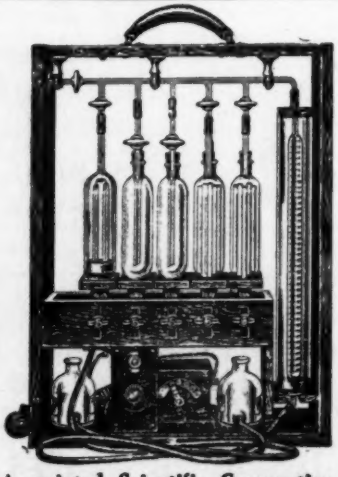

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